An Assessment of Airborne Particulate Matter Concentrations and Deposition in Eliot, Maine

An Ambient Air Monitoring and Analysis Special Project

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Prepared by

The New Hampshire
Department of Environmental Services

NEW HAMPSHIRE
DEPARTMENT OF
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Services

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EXECUTIVE SUMMARY

This report was prepared by the New Hampshire Department of Environmental Services (DES) for the purpose of investigating and analyzing, to the extent practicable, the deposition of airborne particulate matter in the residential community bordering the Piscataqua River in Eliot, Maine. The shoreline on the New Hampshire side of this river consists primarily of industrial development, including two electric generating stations owned and operated by Public Service of New Hampshire (PSNH), Newington Station and Schiller Station.

From August 22, 1999 through September 19, 1999 at a site in Eliot, Maine, DES monitoring equipment sampled ambient total suspended particulate (TSP) concentrations every other day and measured sulfur dioxide (SO_2) concentrations continuously. The monitors were sited in an open field directly across the Piscataqua River from the Newington and Schiller Stations. DES also conducted atmospheric analysis (i.e., dispersion modeling) of emissions from Newington and Schiller Stations (including emissions from both coal handling activities and exhaust stacks) and from marine traffic (which are currently uncontrolled emission sources). In addition, DES investigated the impact of these and other potential sources of particulate matter on the Eliot, Maine area by tracking of local meteorology, studying particulate matter deposition, analyzing TSP samples for certain elemental metals, reviewing New Hampshire Port Authority reports of marine vessel traffic on the Piscataqua River, reviewing files and operation schedules for major stationary sources in the area, and contracting with an independent laboratory for microscopy analyses on TSP and surface wipe samples to further identify particulate matter emission sources.

All monitored levels for TSP and SO_2 during the study period were well below the most recent federal National Ambient Air Quality Standards (NAAQS) and state standards for these pollutants. The highest 24-hour TSP concentration measured in this study was 44 micrograms per cubic meter ($\mu g/m^3$), where the most recent federal and New Hampshire TSP standard of 260 $\mu g/m^3$. Maine's TSP standard is 150 $\mu g/m^3$. The ten highest historical TSP concentrations measured at the same monitoring site between August 1983 and July 1984 (i.e., prior to Schiller Station's conversion to coal) all exceeded 44 $\mu g/m^3$, with a maximum concentration of 100 $\mu g/m^3$ (see Table 4.1). A comparison of TSP data collected as part of this study with that measured in 1983-1984 at approximately the same location prior to the conversion of Schiller Station to coal suggests that particulate matter concentrations in the Eliot, Maine area have improved substantially in the last 15-17 years.

The highest 3-hour average SO_2 level monitored during this study was 55 parts per billion (ppb), which is 11% of the federal and New Hampshire 3-hour SO_2 standard of 500 ppb and 12.5% of Maine's 3-hour SO_2 standard of 439 ppb. The highest 24-hour average SO_2 level monitored during this study was 13 ppb, which is 9% of the federal and New Hampshire 24-hour SO_2 standard of 500 ppb and 15% of Maine's 24-hour SO_2 standard of 439 ppb.

The DES Laboratory also analyzed TSP samples for certain metals. Elemental metals detected in one or more TSP samples include: Antimony (Sb), Cadmium (Cd), Chromium (Cr), Manganese (Mn), Nickel (Ni), Vanadium (V), and Zinc (Zn). Other metals tested for, but not detected in any samples were: Arsenic (As), Beryllium (Be), Cobalt (Co), Copper (Cu), Mercury (Hg)[1], Molybdenum (Mo), Silver (Ag), Thallium (Tl), and Uranium (U). There were no exceedances of the New Hampshire and Massachusetts health-based Ambient Air Limits (AALs) for any of the metals analyzed. There are no federal or Maine AALs for any of these metals.

Although the maximum monitored concentrations of TSP and SO_2 in this study were less than 20% of the most recent NAAQS, further study – including dispersion modeling and atmospheric analysis – was conducted to assess: (1) marine traffic emissions; (2) stack emissions at Newington and Schiller Stations; and (3) fugitive emissions from coal delivery and handling activities. This assessment suggests that the greatest potential particulate matter impacts in the Eliot, Maine area – by more than an order of magnitude – are from fugitive coal dust emissions. Particulate matter impacts from marine traffic and from stack emissions at Newington and Schiller Stations were estimated to be roughly equivalent, each being approximately 10% of fugitive coal dust emissions.

As noted above, absolute ambient TSP concentrations measured during this study were quite low compared to the most recent federal and state air quality standards. However, microscopy analysis of particulate matter samples confirmed that when coal-handling activities were high and the wind was predominantly from the west, coal dust constituted a majority of TSP collected. Mineral matter, biological matter, and ambiguous soots (i.e., those unattributable to a specific source category) constituted most of the remaining fraction of TSP. When the wind was from the east, mineral matter, biological matter, and ambiguous soots constituted the vast majority of particulate matter collected.

A review of other sources of particulate matter in the area surrounding Eliot, Maine was also conducted, including other major stationary sources, mobile sources (e.g., vehicles on Interstate 95 and other roads), and area sources (i.e., largely uncontrolled sources such as residences, light industry, small businesses, and open burning of brush and building debris). This review showed that emissions from numerous local sources of particulate matter also affect the Eliot, Maine area. The precise impact of each specific source is beyond the scope of this project. A review of federal and state regulations applicable to Newington and Schiller Stations and their current air permits revealed no violations of existing regulations or permit conditions by either facility.

[1] Although fossil fuel power plants are known sources of mercury, there were no detections of mercury using Inductively Coupled Plasma/Mass Spectrometry (ICP/MS), the laboratory procedure utilized for metals analysis of the particulate matter samples (dry deposition) collected as part of this study. However, because mercury is typically emitted in gaseous form rather than as particulate matter, mercury levels are more accurately measured in rainwater samples (wet deposition) using Cold Vapor Atomic Fluorescence (CVAP), a method which yields a lower detection limit. The DES Laboratory does not have the capacity to perform CVAP, and collection and analysis of wet deposition samples was outside the scope of this study.

DES estimates the cost of conducting this special project, including laboratory and analytical costs, technical and management personnel time, and miscellaneous costs, to be approximately $34,305.

ACKNOWLEDGEMENT

The New Hampshire Department of Environmental Services extends its appreciation to Ms. Shirley Alden for allowing a temporary ambient air monitoring station to be located on her property in Eliot, Maine for the purpose of gathering data for this study.

ASSESSMENT OF AIRBORNE PARTICULATE MATTER CONCENTRATIONS AND DEPOSTION IN THE ELIOT, MAINE AREA

AN AMBIENT AIR MONITORING SPECIAL PROJECT

1. BACKGROUND

1.1. General

This report was prepared by the New Hampshire Department of Environmental Services (DES), for the purpose of investigating and analyzing, to the extent practicable, airborne particulate matter deposition in the residential community bordering the Piscataqua River in Eliot, Maine. The shoreline on the New Hampshire side of this river is heavily developed with industrial facilities, including two power generation facilities owned and operated by Public Service Company of New Hampshire (PSNH), Newington Station and Schiller Station.

Complaints of "soot" deposition in neighboring towns across the Piscataqua River in Maine were the subject of a letter dated March 17, 1999 from Maine Governor Angus King to New Hampshire Governor Jeanne Shaheen. According to this letter, the complaints targeted emissions from the Newington and Schiller Station facilities as the source of the soot. The New Hampshire Department of Environmental Services (DES) reviewed its files for those facilities for appropriate emission limits, compliance history, and complaint history. In a response letter dated April 28, 1999 from Governor Shaheen to Governor King, it was reported that the emission limits on the Newington and Schiller facilities are consistent with state and federal requirements, and that both facilities have a good record of compliance with all applicable emission requirements. It was further indicated that, because of the variety of air pollution emission sources in the Portsmouth-Eliot-Kittery area (e.g., harbor traffic, motor vehicles, industrial sources, etc.), similar investigations in the past were inconclusive in identifying specific particulate matter sources.

Nevertheless, Governor Shaheen asked DES to assess deposition in the Eliot, Maine area. This report was prepared in response to the Governor's request. The goal of this study was to analyze soot deposition and ambient total suspended particulates (TSP) levels in the area of Spinney Creek Peninsula in Eliot, and to provide – to the extent possible – insight regarding what sources may be responsible for particulate matter in the area.

1.2. Historical Information

In the late 1970's, the U.S. Department of Energy established a policy to diversify the nation's energy sources in order to reduce reliance on foreign petroleum. This action was in direct response to the energy crisis of the mid-1970s. As part of this initiative, PSNH's Schiller Station was required to convert its three primary boilers, Units 4, 5, and 6, from residual oil to coal. This

conversion commenced in November 1984. Prior to this conversion, an air quality analysis[2] was prepared by an environmental consultant to assess the air quality impacts likely to result from the conversion of Units 4, 5, and 6 to coal. The greatest impacts of the conversion to coal were predicted by the consultant to be fugitive dust from the delivery and handling of the coal. In light of this determination, PSNH was required, as a permit condition for Schiller Station, to operate a compliance monitoring network for total suspended particulates (TSP) both prior to and after the conversion to coal. This network consisted of TSP monitors located on the premises[3] Schiller Station and in Eliot, Maine, and was in operation from August 1983 until July 1986, at which time the New Hampshire Air Resources Commission (the predecessor agency to the DES Air Resources Division) informed PSNH that it had demonstrated compliance with state and federal primary ambient air quality standards, and TSP monitoring was discontinued. Since that time, there has been no monitoring for particulate matter specifically targeted to the Newington and Schiller facilities.

[2] Document P-A688, May 1981, "Air quality analysis for the coal conversion of Schiller generating station units 4, 5, and 6", prepared by Environmental Research & Technology, Inc. (ERT).

[3] TSP monitors were situated at two locations on the premises at Schiller Station, and were operated by Normandeau Associates, Inc.

2. METHODOLOGY

2.1. General

Airborne particulate matter concentrations at a given location are a function of its distance from emission sources, the nature of these sources and characteristics of particles emitted, the dispersion characteristics of the emissions points (e.g., stack heights) and the surrounding area (e.g., buildings, variations in terrain, geography) and meteorology (e.g., wind direction and speed). A review of development and transportation patterns in the area of Spinney Creek Peninsula revealed a variety of sources of PM, including marine traffic on the Piscataqua River and in Portsmouth Harbor, other industrial sources, wind blown mineral material (e.g., soil particles, sea salt, pavement dust), motor vehicles (e.g., tire dust, gasoline soot, diesel soot, brake dust), residential fuel burning devices, secondary PM formation from more distant sources, and biological PM (e.g., pollen, mold spores, small insects, small pieces of vegetation).

This study focused on the analysis of total suspended particulate (TSP) samples collected at a site on Spinney Creek Peninsula. A TSP sampler was used for this project primarily because it was the only particulate monitor not otherwise in use at DES. In addition, TSP monitors have no pre-filter medium, and therefore do not discriminate by particle size. This feature was necessary to meet the needs of this study, because it allows of the entire range of airborne particulate matter to be collected and analyzed. To enable further analysis of the TSP samples, DES also:

- Computed ambient concentrations of TSP and compared them with federal and state health-based standards
- Monitored continuously for sulfur dioxide (SO_2)
- Performed dispersion modeling on the PSNH facilities and marine traffic
- Tracked wind direction and speed at two nearby monitoring sites
- Analyzed certain TSP samples for certain elemental metals
- Collected wipe samples from the platform surface where the monitor was mounted
- Reviewed harbor ingress and egress logs for marine vessel activity
- Had microscopy analyses conducted for certain TSP and wipe samples
- Reviewed permit files and operating schedules for the Newington and Schiller Stations and other New Hampshire stationary sources during the period that TSP samples were taken.

2.2. Sample Site Selection

Selecting a site from which to conduct a study of this nature involves a number of considerations, including study objectives, equipment types to be employed, availability of electricity, ability to secure landowner permission, and the siting criteria (e.g., exposure, sources of interference) and security required for the air monitoring methods chosen. For this study, an initial survey was conducted for the Eliot, Maine area, consisting of a review of maps, aerial

photographs and on-site visits coordinated through a handheld GPS system to evaluate a number of potential monitor locations. Figure 2.1 is an aerial photograph of the Portsmouth/Newington/Eliot area, highlighting key landmarks. Figure 2.2 provides a photographic perspective from the selected monitoring site (in Eliot, ME) looking westward across the Piscataqua River toward Schiller and Newington Stations.

After completing this area survey, DES concluded that an open field on Alden Lane was the best location from which to conduct the air sampling necessary to properly assess the nature of the particulate deposition in Eliot. The Alden Lane field provided the open area necessary for the sampling methods to be used, as well as unimpeded and representative airflow from the New Hampshire side of the Piscataqua River (i.e., full exposure to particle deposition under normal conditions, prevailing winds are typically out of the southwest). Electricity was readily available, the location was reasonably secure, and the landowner was willing to allow DES to use the property temporarily for the purpose of conducting the study. Further, this location was very near the site used for the particulate monitoring performed from June 1983 to August 1986 by a consulting firm[4] as a temporary permit condition for Schiller Station when this facility's boilers were converted to burn coal. This historic monitoring is discussed in greater detail in Section 4.

2.3. Total Suspended Particulates (TSP) Monitoring

Total Suspended Particulates is a measure of the concentration of airborne particulate matter, regardless of particle size, origin, or density, under prescribed conditions. A set volume of air is drawn through a filter media over a specified period of time, and the concentration of TSP is computed using the results of a gravimetric analysis (the comparison of TSP filter weights before and after sampling) of the filter and the computed volume of air drawn through the filter. The only criteria for a particle to be eligible for collection on the filter media is that it be airborne. Modern standards for PM (the current federal NAAQS for PM is known as PM_{10}, or particle matter 10 microns and smaller) require that monitors screen out the larger fraction of PM. For the purpose of this study, DES was interested in studying all airborne PM. Because it does not have any pre-screening media and can collect all airborne PM of virtually any size, the TSP monitor was the most ideal for this application.

DES utilized a General Motor Works TSP monitor equipped with a timer. This allowed TSP samples to be collected from midnight to midnight[5] every two to three days, as staff resources allowed, during the monitoring period from August 22, 1999 through September 19, 1999. The samples were delivered to the DES Laboratory for analysis.

[4] PM monitoring during the period June 1983 to August 1986 in conjunction with the conversion of Schiller Station to burn coal was performed by Normandeau Associates, Inc., Bedford, NH.

[5] TSP samples are typically collected over a period of 24 hours.

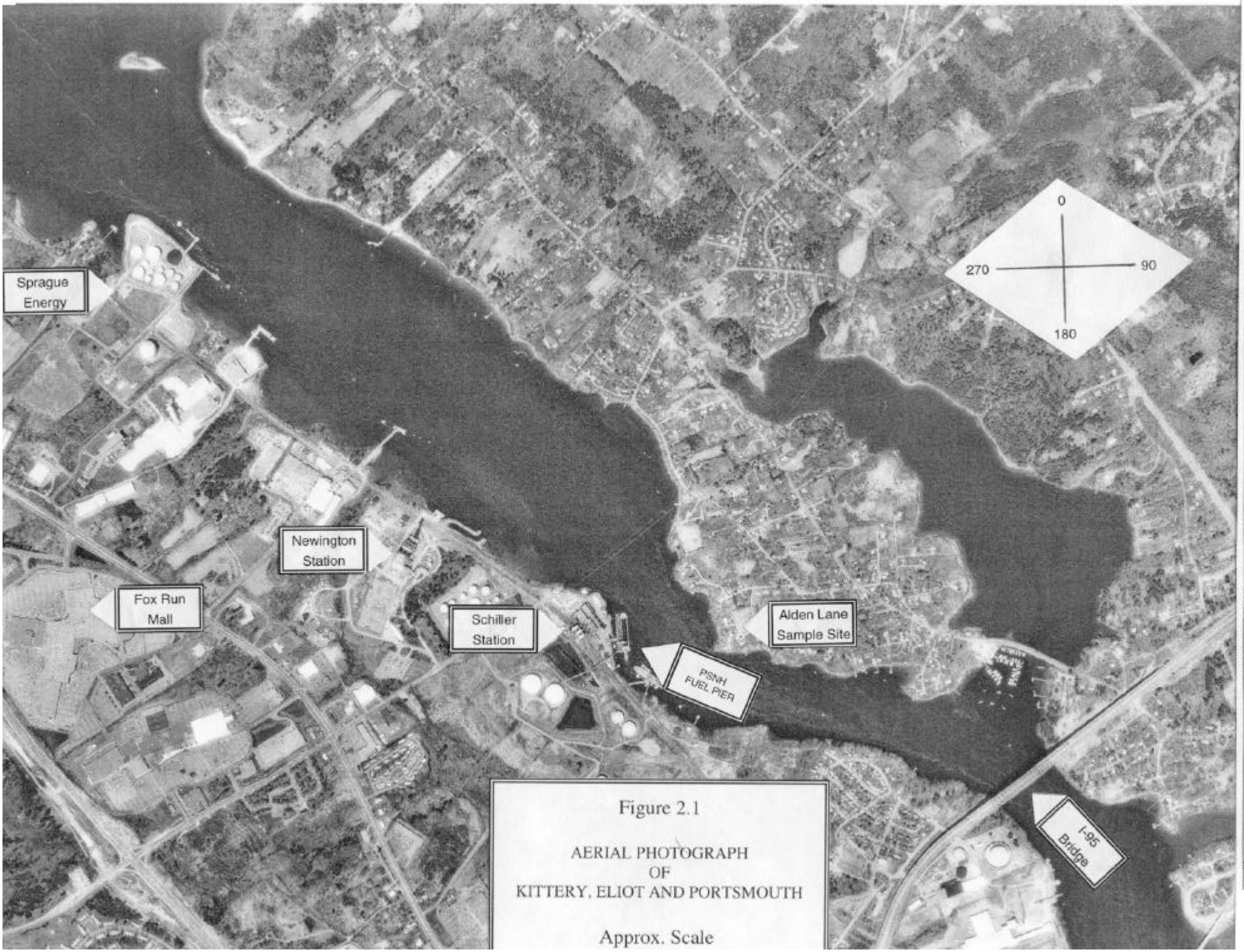

Figure 2.1

AERIAL PHOTOGRAPH
OF
KITTERY, ELIOT AND PORTSMOUTH

Approx. Scale

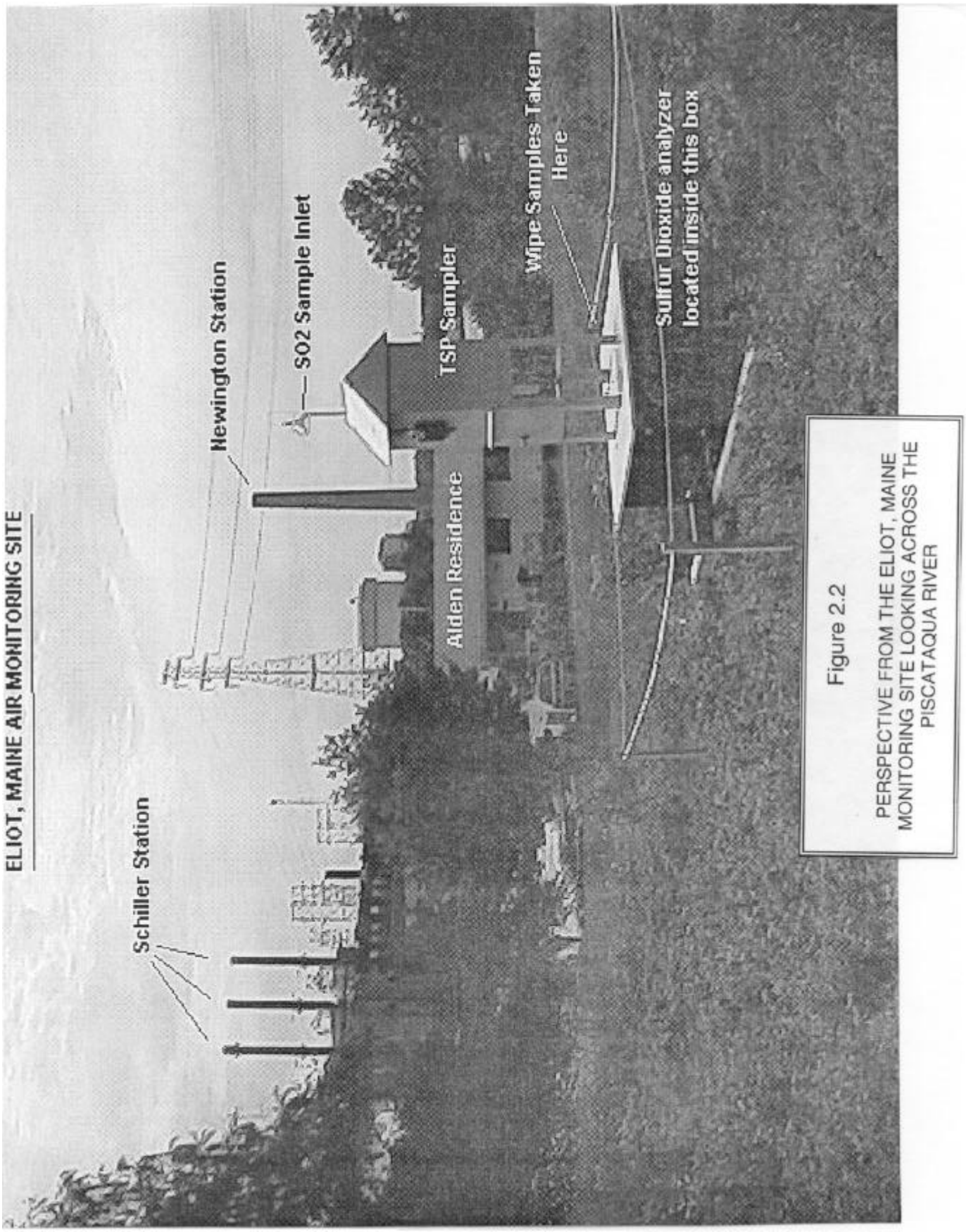

Figure 2.2

PERSPECTIVE FROM THE ELIOT, MAINE MONITORING SITE LOOKING ACROSS THE PISCATAQUA RIVER

2.4. Sulfur Dioxide (SO_2) Monitoring

Sulfur dioxide was monitored continuously throughout this study using a Thermo Environmental Corporation Model 43-C ambient sampler, operated in the 0 to 500 parts per billion (ppb) range[6]. Sample air was collected at a point approximately six feet above the ground, roughly the same height as the intake for the TSP monitor. Electronic output from the analyzer was routed to an Esterline Angus Model MS401C strip chart recorder which was housed inside the wooden box next to the SO_2 analyzer. The analyzer was calibrated prior to and after deployment, and periodic zero checks were performed on the instrument while in the field. It must be noted that normal quality assurance for SO_2 monitoring includes strict temperature control of the environment that the monitor is housed in (i.e., heating and/or air conditioning). Because a climate-controlled mobile monitoring trailer was not available for this special project, DES was unable to provide strict temperature control for the SO_2 monitor. However, all operations were found to be normal throughout the study period, so DES considers the SO_2 readings to be valid for the limited purposes of this study.

SO_2 levels, although monitored continuously, are reported as hourly averages. National Ambient Air Quality Standards (NAAQS) and individual state standards for SO_2 include standards for 3-hour average SO_2 levels, 24-hour average SO_2 levels, and annual arithmetic mean. SO_2 levels monitored during this study are compared to the NAAQS and New Hampshire and Maine state standards in Section 4. In addition, the SO_2 levels are compared to those recorded at two other sites operated by DES during the same period (Keene and Portsmouth). Hourly average SO_2 levels and wind direction are graphed for each day during the study period in Appendix A.

Because significant SO_2 sources include major fossil fuel combustion sources, initial planning for SO_2 monitoring included using it to complement wind direction and speed data from other locations to help identify conditions consistent with greatest impact from the direction of Newington and Schiller Stations. Even though SO_2 concentrations were not expected to be high relative to federal and state standards, evidence of an SO_2 plume (even at low concentrations) could serve as an indicator of periods when PM emitted from the power plants would likely be greatest.

2.5. Surface Wipe Samples

As part of this study, DES monitored the accumulation of particulate matter on the surface of the platform supporting the air monitoring equipment in order to characterize the nature of the deposited materials. To accomplish this in a representative manner, the horizontal platform upon which the high volume air sampler was mounted was painted white, and a portion of its upper surface was designated as the test plot for taking wipe samples. A section of the platform measuring 1 foot by 1 foot was delineated, and samples were taken on this same surface every time the site operator visited the sampler (weather permitting). This sample regime was designed to develop a chronological record of deposition at the monitoring site which could be retained and analyzed further.

[6] 0 to 500 parts per billion (ppb) is the standard operating range for ambient air monitoring of SO_2.

Wipe samples were collected from the designated portion of the surface of the monitoring platform during each site visit[7]. The designated area was then cleaned thoroughly with a fresh wipe to ensure that material collected on the next visit would be "new." Fiber-free paper laboratory wipes, pre-moistened with distilled water and alcohol, were used to collect samples. The procedure called for the site operator to fold a wipe into quarters and collect the sample using straight, parallel strokes until all of the material within the designated area had been collected. Immediately after sample collection, the wipe containing the sample was placed in a Ziplock bag, which was then sealed and labeled with a distinct sample number according to the date the sample was collected. Sample information was then entered in the site operator's logbook, including the date, time and the name of the site operator who collected the sample. If there appeared to be material relevant to the study outside of the designated sample area, the site operator was permitted to exercise discretion in sample collection to take multiple samples on the platform surface. In all cases, a sample was taken within the designated area first. If it was raining, no sample was taken. If the platform was wet from precipitation, the taking of a sample was at the discretion of the site operator.

2.6. Dispersion Modeling

In addition to air sampling for TSP and SO_2, DES also conducted a dispersion modeling analysis to better assess the potential impacts of several nearby emissions sources on the Spinney Creek Peninsula area. Dispersion modeling is a computer simulation of the dispersion of air pollutants into the ambient air after they leave a particular source or sources. Dispersion modeling utilizes source-specific input data, such as stack height, stack diameter, exhaust temperature and velocity, as well as local meteorological data and information on the surrounding terrain to produce a conservative prediction of the resulting concentrations of pollution in the air at specific points downwind.

For this analysis, DES used dispersion modeling to assess the contributions to particulate matter impacts in the Eliot, Maine area from:

- The stacks at Newington and Schiller Stations;
- Coal unloading and handling operations at Schiller Station;
- Ship emissions at the PSNH fuel pier (located adjacent to Schiller Station); and,
- Ship traffic on the river.

Limitations of standard dispersion models preclude an assessment of impacts from vehicles, such as those traveling on nearby I-95 (located east of the monitoring site), or from biogenic, smaller commercial, and population-based sources. In addition, there was no assessment of transported PM. Further technical detail on the dispersion modeling methodology is discussed in Section 3.

[7] Site visits were scheduled for the purpose of changing the filter on the TSP sampler. Wipe samples were collected and documented for each site visit.

2.7. Wind Conditions

Since available resources did not include installation of a meteorological tower for recordation of wind data at the monitoring site, wind direction and speed data for this study were drawn from DES's Portsmouth air monitoring site, which is located about two miles Southeast of the Eliot site. The predominant wind data typically does not vary significantly between these two locations.

2.8. Metals Analyses

DES's laboratory analysis of the TSP filter samples collected during this study included Inductively Coupled Plasma/Mass Spectrometry (ICP/MS) to determine concentrations of the following elemental metals: Antimony (Sb), Arsenic (As), Beryllium (Be), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Mercury (Hg)[8], Molybdenum (Mo), Nickel (Ni), Silver (Ag), Thallium (Tl), Uranium (U), Vanadium (V), and Zinc (Zn).

The measured concentrations of these elemental metals were compared to the corresponding New Hampshire and Massachusetts State Ambient Air Limits (AALs)[9]. (In New Hampshire, AALs are established by the Bureau of Health Risk Assessment in the Office of Community Public Health of the Department of Health and Human Services, and implemented via rule by DES.) The original purpose of these analyses was to help assess possible source attribution of particulate matter. However, because there are numerous potential emission sources in the area other than power plants (e.g., vanadium sources other than residual oil and coal combustion include smelter fine, incinerators, and sea salt; other manganese sources include paved and unpaved road dust, motor vehicles, and construction activities), conclusive attribution of particulate matter sources via metals analysis is not possible. See Table 5.3 for additional information regarding sources of metals in particulate matter.

2.9. Microscopy Analysis

Microscopic analysis of the particles, using polarized light microscopy (PLM) and scanning electron microscopy coupled with an energy dispersive x-ray detector (SEM-EDX), was performed on selected TSP filter samples and wipe samples. The analyses were performed by Severn Trent Laboratories, an independent laboratory located in Billerica, MA. The purpose of the microscopic analysis was to break down, to the extent possible, particle character distribution. In the laboratory, particulate matter was removed from the sample media using

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[8] Although fossil fuel power plants are known sources of mercury, there were no detections of mercury using Inductively Coupled Plasma/Mass Spectrometry (ICP/MS), the laboratory procedure utilized for metals analysis of the particulate matter samples (dry deposition) collected as part of this study. However, because mercury is typically emitted in gaseous form rather than as particulate matter, mercury levels are more accurately measured in rainwater samples (wet deposition) using Cold Vapor Atomic Fluorescence (CVAP), a method which yields a lower detection limit. The DES Laboratory does not have the capacity to perform CVAP, and collection and analysis of wet deposition samples was outside the scope of this study.

[9] AALs for the metals analyzed as part of this study have not been adopted by EPA or the State of Maine. Therefore, comparisons with AALs were restricted to those that have been adopted by the States of New Hampshire and Massachusetts.

specialized laboratory tape. From that sample, a group of 100 randomly selected particles were counted and categorized by most likely source of origin.

For wipe samples, a general distribution was computed for opaques (e.g., coal dust, soot, black dust), mineral grains (crustal materials), and biologicals (e.g., spores, pollen). For TSP samples, a distribution was computed using the proportion of particles fitting various PM composition groupings (e.g., mineral material, road dust, oil soot, coal dust, biological material, etc.). A second distribution was computed for the weight distribution of the particles within the same groupings based on particle density.

Microscopic analysis is costly and has the limitation that samples taken from filter media are only representative of the 100 particles drawn from the sample for microscopy anlysis. DES chose samples for microscopy based on the prevailing wind direction during the time samples were collected. Some samples were chosen to be representative of worst case impacts from Newington and Schiller Stations (i.e., as PSNH was receiving a shipment of coal with westerly winds consistent with conditions of greatest impact from Newington and Schiller Stations on Spinney Creek Peninsula). A comparative sample was selected when the predominant wind was from the southeast (i.e., primarily from the Interstate 95 corridor and downtown Portsmouth).

2.10. Additional Review

As part of this study, DES also reviewed marine vessel emissions (limited to larger vessels and tugboats) in the Piscataqua River, emissions from major New Hampshire stationary sources, and other sources of emissions that are typical of activity in the region (e.g., vehicles, population-based fuel use, open burning, etc.). DES also investigated photographic evidence, provided by a resident on Spinney Creek Point, of high opacity emissions in the proximity of Schiller Station. The purpose of this additional review was to consider all air pollution emission sources in the area that could potentially impact the Spinney Creek Point area of Eliot, Maine.

3. DISPERSION MODELING

3.1. General

As part of this study, DES conducted a dispersion modeling analysis to assess the potential impacts of nearby sources. As mentioned earlier, dispersion modeling is a computer simulation of the dispersion of air pollutants into the ambient air. Dispersion modeling utilizes input data including source parameters (e.g., emission rates[10], emission height, stack gas velocity, stack temperature), meteorological data, and information about the surrounding terrain to produce a conservative prediction of the air pollution impacts of specific sources.

Dispersion models are used primarily as tools for determining the compliance status of stationary sources for permitting purposes, providing conservative estimates of maximum concentrations of regulated pollutants for comparison with air quality standards and emission limits. The models are typically run assuming "worst case" scenarios as a guide for establishing permit conditions, if any, for an existing or proposed source. For this study, dispersion modeling was performed to assess the contribution to PM concentrations in the Eliot area from the existing PSNH facilities (Newington Station, Schiller Station), from coal delivery and handling activities at Schiller Station, and from marine vessels traveling on the Piscataqua River. The nature of dispersion modeling does not allow it to accurately quantify the cumulative effects all pollution sources in the Eliot area, such as mobile, area and certain types of stationary[11] sources.

3.2. Input Data and Assumptions

For this analysis, DES looked at the contributions to particulate matter (PM) impacts in the area of the monitoring site from: 1) coal unloading and handling operations at Schiller; 2) emissions from marine vessels, including both in-port ships at the fuel pier adjacent to Schiller Station and ship traffic on the river; and 3) emissions from the stacks at Newington and Schiller Stations.

3.2.1. Coal Unloading and Handling Operations

For the coal handling operations, a single coal ship was assumed to offload 600 tons/hour of coal (based on ship coal capacity data) at the PSNH dock for 72 consecutive hours. The coal was assumed to travel by conveyor to the coal pile at the facility during this entire time. Emissions from this type of operation are considered to be "fugitive" and are dependent on the size and moisture content of the coal dust particles as well as the wind conditions at the time. Data on the properties of the coal itself were obtained from the U.S. Environmental Protection Agency

[10] Emission rates are a function of combustion device design, type of fuel burned, temperature of combustion and other operating conditions, and applicable emission controls. For permitted stationary sources, most of these parameters are available. For sources where little is known, such as marine vessels, several assumptions have to be made to accommodate dispersion model inputs.

[11] Other permitted NH stationary sources which could have some impact on PM and/or SO2 concentrations at the monitoring site in Eliot, ME are detailed in Table 5.6.

(EPA). Coal dust emission rates were calculated both assuming average annual wind speed (8 mph) and high wind conditions (16 mph). High wind conditions were calculated to result in emissions approximately 2.5 times greater than emissions at average wind speed conditions, based on an exponential equation developed by EPA. The modeling assumed no controls on the fugitive coal dust emissions. The results of the air quality modeling analysis of PM from coal handling are shown graphically in Figure 3.1.

3.2.2. Emissions from Marine Vessels

Several assumptions were also needed to estimate the impacts from the stacks on the coal and oil ships at the fuel pier as well as from various vessels in transit. Emission rates were calculated using EPA emissions data for large diesel generators and industrial boilers. Since little data exists regarding PM emissions from shipboard engines, a conservative factor was applied to the calculated emission rates. Stack gas parameters were taken from similar engines for which accurate data exist. A stack height of 100 feet above mean sea level was assumed for the coal and oil ships. A stack height of 40 feet was assumed for the tugboats. The results of the air quality modeling analysis for PM from a ship in port at the Schiller Station fuel pier are shown graphically in Figure 3.2.

Ship traffic in motion on the river is particularly difficult to model because their emissions and emission points both vary over time. For these sources, the ships were assumed to be stationary near Spinney Creek Peninsula for a period of one full day. The results of the air quality modeling analysis for a marine vessel out on the Piscataqua River are shown graphically in Figure 3.3.

3.2.3. Emissions from the Stacks at Newington and Schiller Stations

Information on stack parameters and PM emissions from Newington and Schiller Stations is well documented, and dispersion from these facilities has been modeled numerous times in the past. In all cases, the facilities have been in compliance with applicable state and federal air quality standards. Information on the coal handling operations, however, is less well known, so assumptions had to be made in order to estimate its impacts. Much of the data were taken from the original 1981 air quality analysis and modeling for the coal conversion project at Schiller Station[12]. More recent information from ship records and site visits was also used to better characterize coal dust emissions. The results of the air quality modeling analysis of PM emissions from the stacks at Newington and Schiller Stations are shown graphically in Figure 3.4.

3.3. Discussion

Figures 3.1 – 3.4 illustrate the maximum model-predicted impacts of PM for the different sources analyzed. Each map presents isopleths whose lines show equal PM concentrations, representing the maximum 24-hour average impact in the area of the monitoring site as predicted by the model for a 5-year period of data (the period typically used in dispersion modeling

[12] Document P-A688, May 1981, "Air quality analysis for the coal conversion of Schiller generating station units 4,5, and 6", prepared by Environmental Research & Technology, Inc. (ERT).

analyses). The impacts presented are therefore the worst possible conditions that can be expected to occur over the course of a single day, based on each source emitting at its highest rates.

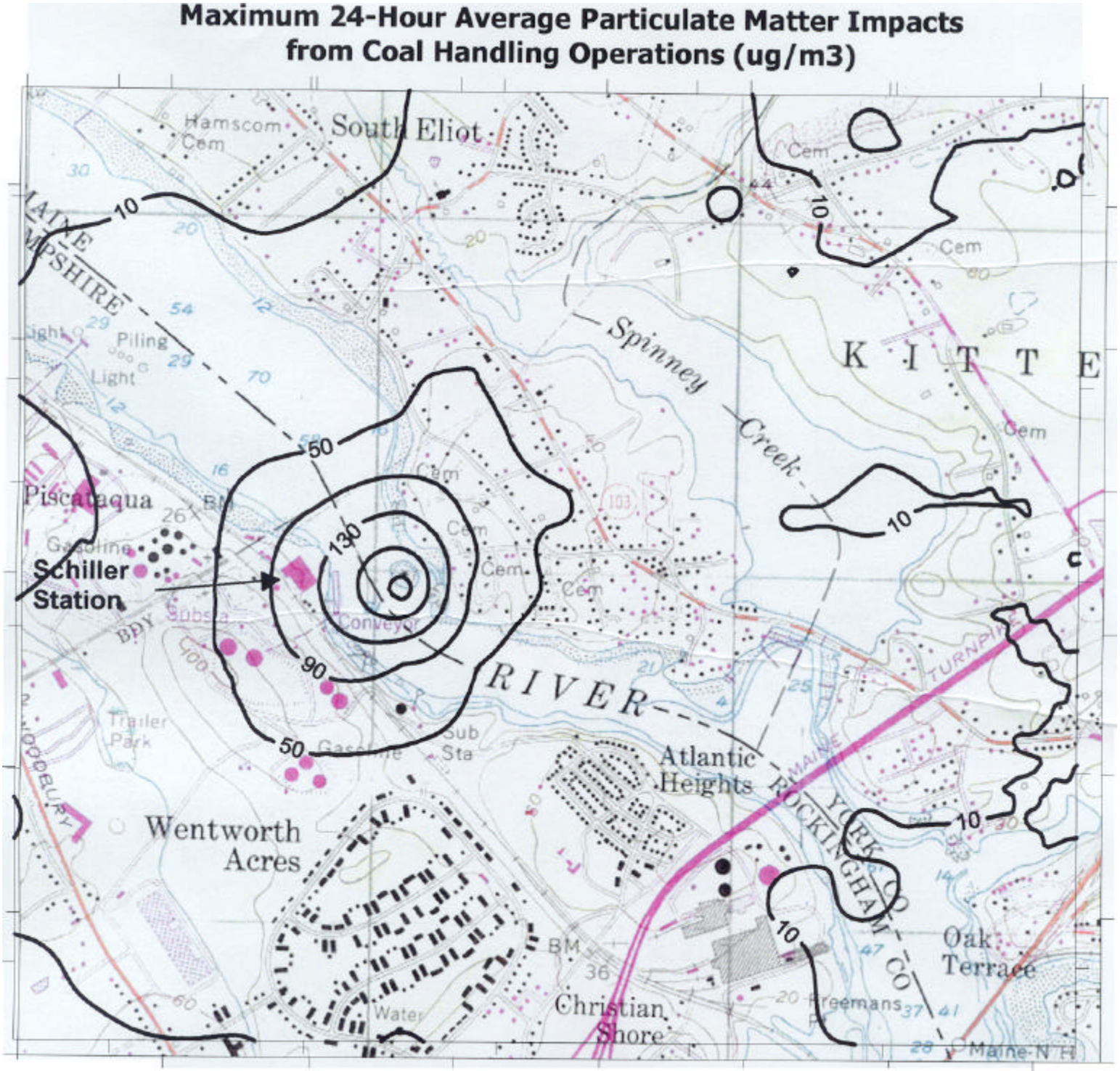
Due to the level of conservatism inherent in these and other assumptions, the results predicted by the dispersion modeling analysis should not be taken as a predicted actual quantitative assessment of air quality impacts. Instead, this analysis should be viewed as a qualitative estimate of the relative contributions of the various sources to TSP impacts in the area of the monitoring site, and to determine the areas most likely to experience the greatest impact under worst-case conditions. Actual monitored levels of TSP in Eliot, Maine during the study period (see Section 4 - Ambient Air Monitoring) were well below levels that are considered threatening to public health. The impacts from the coal handling operations are seen to be concentrated in the river not far downwind of Schiller Station.

Of all the sources modeled for PM, the coal handling operations (coal offloading plus conveying) produced the highest impacts (Figure 3.1). Not surprisingly, due to the relatively large size of the coal particles, the maximum concentrations of PM were predicted to occur immediately adjacent to the PSNH facility. These concentrations drop off significantly as one moves further away from the plant. PM impacts from the other sources (i.e., PSNH stacks, diesel-powered ships) are more dispersed because the PM is emitted higher above the ground and/or in lower volume. Correspondingly, the PM concentrations from these sources are expected to be significantly lower than those from coal loading and conveying. Using emission rates derived for average wind conditions, the maximum predicted short-term PM impacts of coal handling at the PSNH facility were estimated to be about 10 times the PM impacts from the steam generating units and combustion turbine at Schiller station, while under high wind conditions the impacts were estimated to be about 25 times more. This is not surprising since the fugitive emissions from the coal handling processes are released much closer to ground level than the emissions from the main Schiller stacks, which are 226 feet high.

These results are consistent with the assessment made in the 1981 analysis, which showed that fugitive impacts dominated the total predicted PM concentrations, even though the total emissions from the combustion sources are higher. It should be noted that the PM impacts in the area of the monitoring site due to Newington station were predicted to be higher than those from the closer Schiller station. This is due to the fact that the PM emissions from Newington station are significantly higher than from Schiller, assuming both units are operating at their maximum permitted conditions. In the case of Newington station, this is not likely since the plant is a peaking facility, meaning that it operates only when there are high power demands in the Northeast. Therefore, this source is often not in continuous operation as was assumed in this analysis. Schiller station, on the other hand, is a base-loaded power generating facility, which means it is typically in operation around the clock.

Figure 3.1

Dispersion Modeling Isopleth Graph



one-half mile

Figure 3.2

Dispersion Modeling Isopleth Graph

Maximum 24-Hour Particulate Matter Impacts from Ship in Port at Schiller Station (ug/m3)

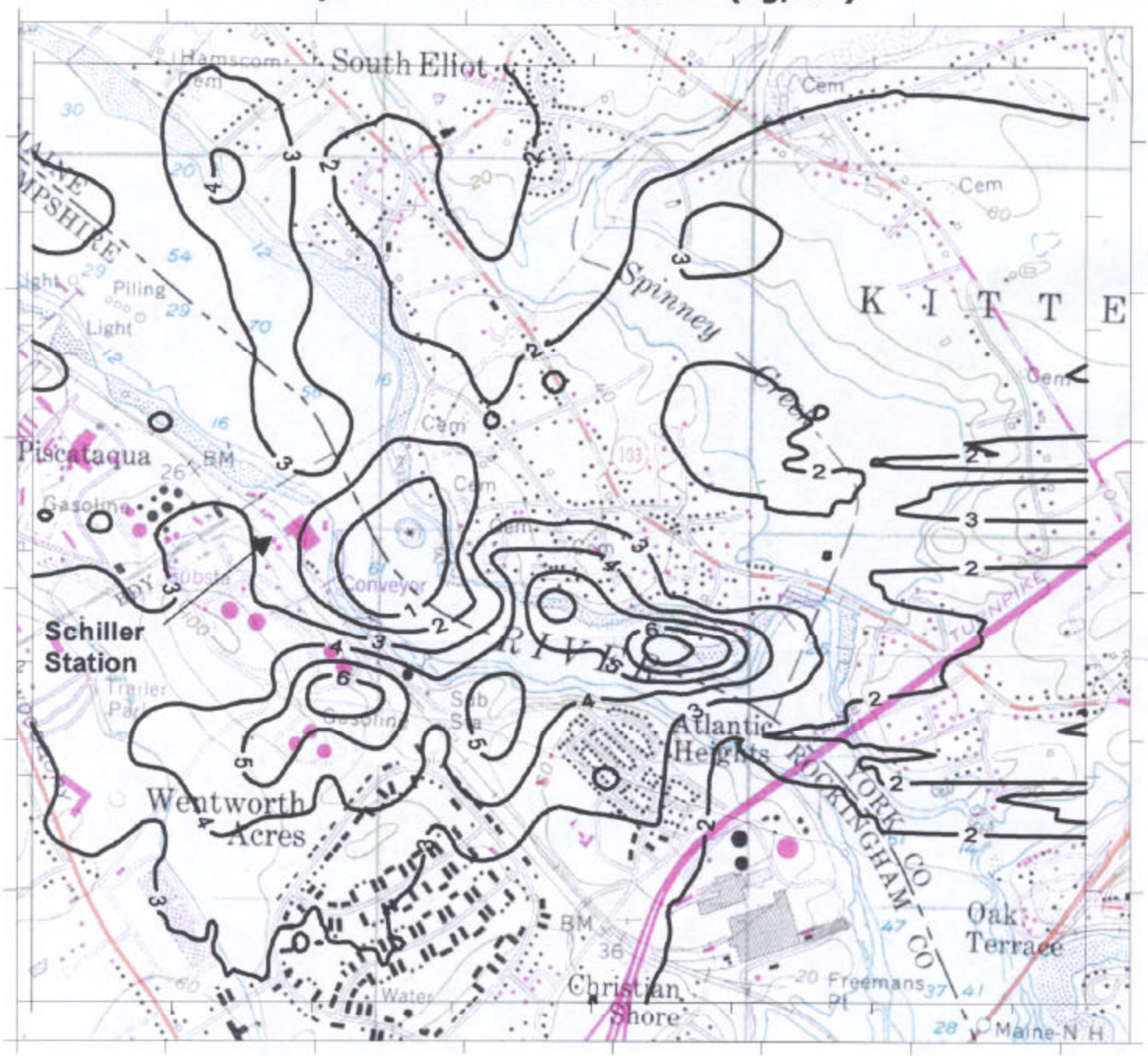
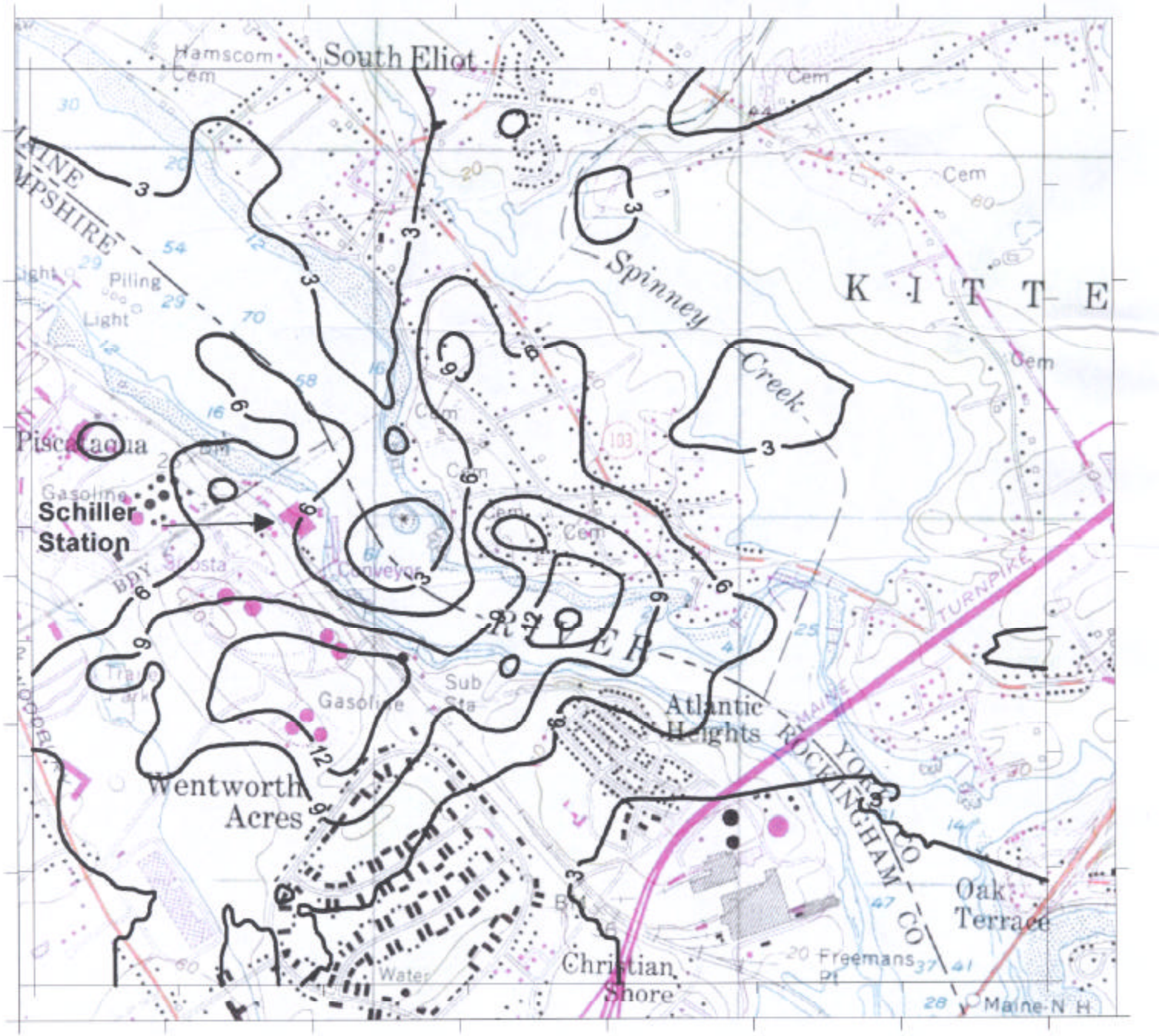


Figure 3.3

Dispersion Modeling Isopleth Graph

Maximum 24-Hour Particulate Matter Impacts from Tug Boat Traffic on River (ug/m3)

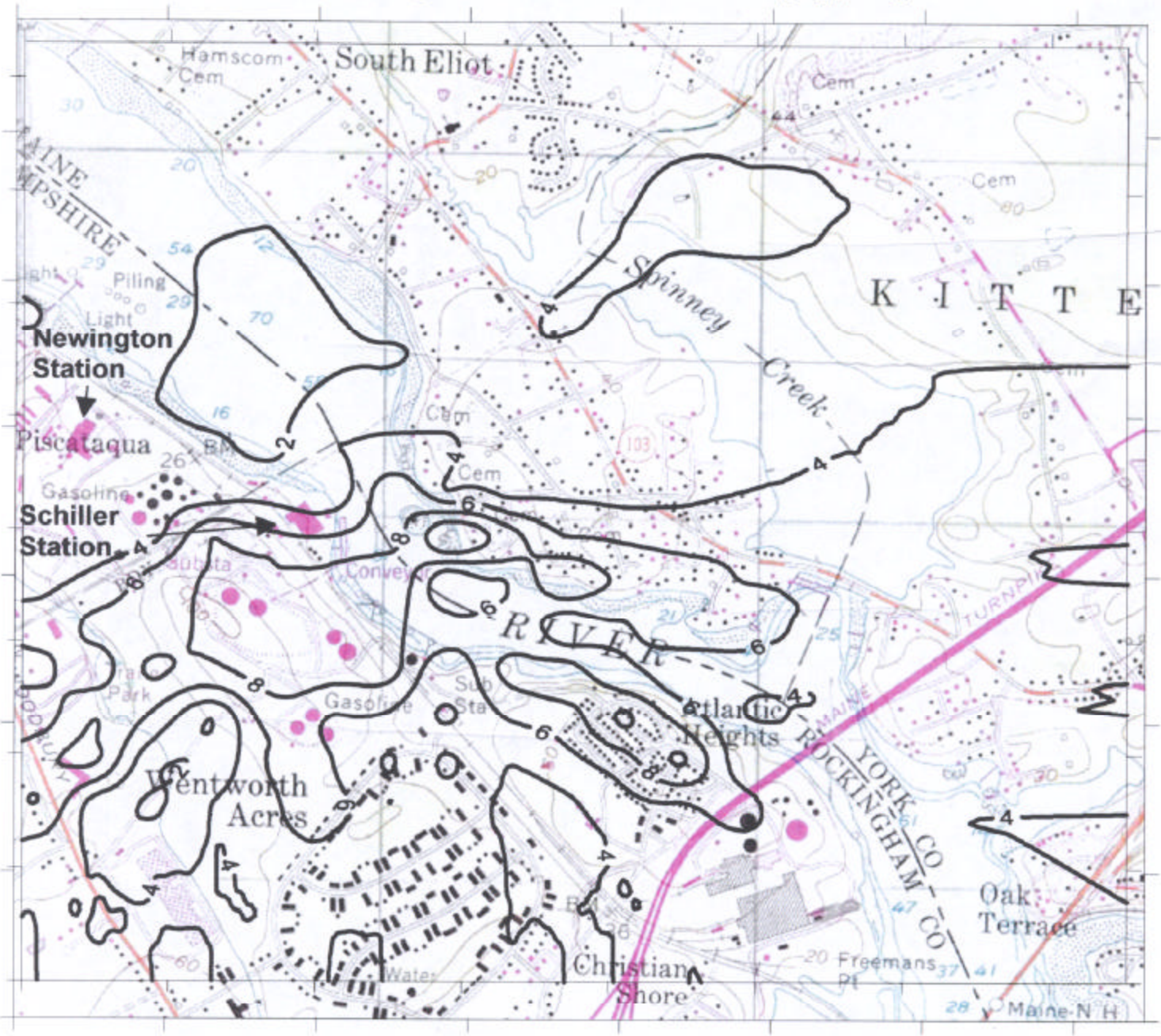


one-half mile

Figure 3.4

Dispersion Modeling Isopleth Graph

Maximum 24-Hour Average Particulate Matter Impacts from Newington and Schiller Stacks (ug/m3)



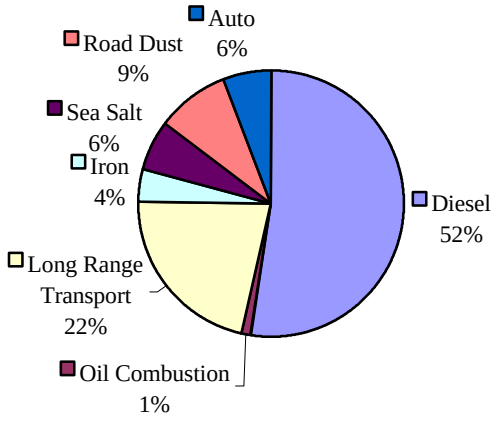
4. AMBIENT AIR MONITORING

4.1. Total Suspended Particulates

Total suspended particulates (TSP) designates total airborne PM of all sizes. TSP includes PM present in the air as a result of natural phenomena (such as windblown crustal matter, pollen, volcanic dust, and secondary PM), and human activities (such as industry, construction, fuel combustion, vehicular traffic, and agriculture). The concentration of TSP present in the air at any point and time is a function of proximity to sources of PM, the nature of these sources, dispersion characteristics of the surrounding area, and meteorological conditions (e.g., humidity, precipitation, wind speed and direction).

Speciation data for PM is not widely available, however some studies have been done which provide some insight on the source of PM. Figure 4.1 reflects speciation of PM_{10}[13] samples collected at a midtown Manhattan site (New York City). As illustrated by this chart,

Figure 4.1 – PM_{10} Average Source Contribution to Midtown Manhattan Site
Data Source: Air & Waste Management Association, Paper 94-WP91.01, prepared by D.N. Witlorf.



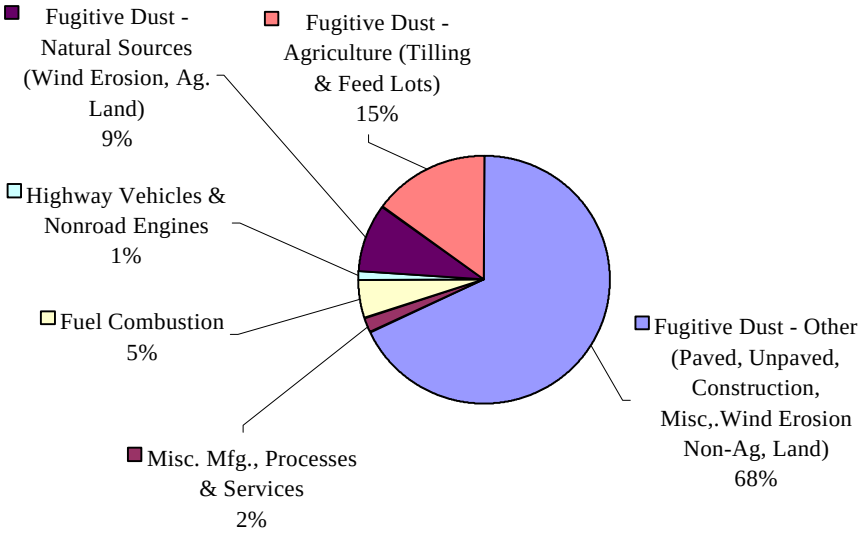
metropolitan areas experience higher concentrations of anthropogenic (man made) PM, diesel soot is the dominant metropolitan source. This includes emissions from trucks, buses, construction equipment, and home heating oil combustion[14].

[13] PM_{10} is particulate matter that is 10 microns or less in diameter.

[14] Today's diesel for on-highway use is essentially the same product as home heating oil (No. 2 distillate fuel). Diesel fuel is a somewhat more refined product for use in internal combustion engines (e.g., vehicles, marine engines, some stationary applications), often contains proprietary additives, and is blended for seasonal use to

Figure 4.2 is a pie chart of overall PM_{10} emissions in the U.S. by source category, drawn from emissions inventories around the nation. On a national basis, the dominant source of PM is windblown soil, occurring either naturally or as the result of agricultural activities. In New Hampshire, because of the nature of the vegetation and weather, biogenic sources of PM contribute a greater portion of total TSP as plants and trees respond to the changing seasons.

Figure 4.2 – U.S. 1990 PM_{10} Emissions by Source Category
Data Source: U.S. EPA National Air Pollutant Trends Inventory for 1990.



For the purpose of this study, a TSP monitor was used to collect samples of airborne particulate matter in the area of Spinney Creek Peninsula in Eliot, Maine. TSP monitors do not discriminate by particle size, so all airborne PM can be collected on the filter media. This allows for analysis of the entire spectrum of PM in the air at the time of sampling, including larger particles that are visible upon deposition and smaller, invisible particles that may remain airborne for vast distances from the source depending on meteorological conditions.

PM monitoring originally required by the Clean Air Act consisted primarily of TSP monitoring until 1987. Following scientific studies that showed that the smaller particle fraction poses

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respond to anticipated ambient temperature changes. engines, some stationary applications), often contains proprietary additives, and is blended for seasonal use to respond to anticipated ambient temperature changes.

greater risk to public health, the federal TSP standard[15] was replaced by a new standard for PM_{10} (airborne particles 10 microns or less in width). The human respiratory system has mechanisms that intercept particulates to prevent them from getting deeper into the lungs (which are in essence a system of increasingly smaller tubes), and potentially into the blood stream. These mechanisms are effective with larger particles, but do little to prevent smaller particles from getting into the lungs. In addition, smaller particles (such as that from diesel fuel) often contain more toxic substances than larger particles. Empirical estimates suggest that, on average, the PM_{10} fraction represents approximately 65% of TSP. However, the particle size distribution of any given sample can vary dramatically, so direct comparison of PM_{10} and TSP concentrations is not feasible. The EPA proposed a new PM standard in 1998, known as the $PM_{2.5}$ standard (airborne particles 2.5 microns or less in width/diameter), once again in light of newer scientific studies that link greater health risks to smaller sized particles. Although sampling for $PM_{2.5}$ has begun, this new standard has not yet been implemented because it was litigated and remanded back to EPA.

In this study, DES collected 15 TSP samples on quartz filters. The TSP concentrations computed from these samples are listed in Table 4.1. Because little TSP monitoring has been conducted since the introduction of the PM_{10} standard, DES has provided historical TSP data from sites in Dover, Kittery ME, Manchester (Police Department location), Portsmouth (Vaughan Street location), and Eliot, Maine[16] for the purpose of comparison.

All of the TSP concentrations computed from the samples taken during this study were well below the previous federal, New Hampshire, or Maine 24-hour average TSP standards. When they were in place prior to 1988, the federal TSP NAAQS and New Hampshire 24-hour average standards[17] were 260 $\mu g/m^3$. Maine's 24-hour average TSP standard was 150 $\mu g/m^3$. The highest 24-hour TSP concentration was experienced at the monitoring site on August 28, 1999, and was analyzed to be 44 micrograms per cubic meter ($\mu g/m^3$), or 17% of the most recent federal and New Hampshire TSP NAAQS.

August 28, 1999 is considered to be a worst-case scenario relative to PM impact from Newington and Schiller Stations, as both facilities were in operation on that day, and PSNH was receiving a shipment of coal via cargo ship. In addition, the wind was blowing generally from the west (see Page A7), consistent with the greatest expected impacts at the monitoring site from the two power plants. Despite these conditions, monitored PM levels were well below the most recent TSP standards.

TSP monitoring was conducted routinely at several sites in New Hampshire during the 1980s. In addition, as part of an impact study conducted in conjunction with the conversion of Schiller

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[15] The federal 24-hour average TSP standard, when in place (prior to introduction of the PM_{10} standard), was 260 micrograms per cubic meter ($\mu g/m^3$) and allowed for one exceedance per year. The federal annual arithmetic mean TSP standard was 75 $\mu g/m^3$. New Hampshire's TSP standards were the same as the federal standards. Maine's 24-hour average TSP standard, when in place (prior to introduction of the PM_{10} standard), was 150 $\mu g/m^3$, with no allowable exceedances. Maine's annual arithmetic mean TSP standard was 60 $\mu g/m^3$.

[16] Historic TSP monitoring in Eliot, ME was performed as part of the temporary permit requirements for Schiller Station at the time of its required conversion to burn coal. See Section I (Background).

[17] The old TSP standard was based on a sampling schedule of one 24-hour sample every six days.

Station to coal, TSP monitoring was conducted from August 1983 through July 1986 at the same site in Eliot, Maine that DES utilized for this study. Table 4.1 illustrates that from August 1983 to July 1984 (see also footnote 16), prior to the conversion of Schiller station to coal, each of the

Table 4.1 – Total Suspended Particulates (TSP) Concentrations

Eliot, Maine – 1999 DES Special Study		1983 Ten Highest 24-Hour TSP Concentrations* (prior to conversion of Schiller Station to coal)				
Date	24-Hour TSP* Concentration ($\mu g/m^3$)	Dover NH ($\mu g/m^3$)	Portsmouth NH ($\mu g/m^3$)	Manchester NH ($\mu g/m^3$)	Kittery ME ($\mu g/m^3$)	Eliot ME[18] ($\mu g/m^3$)
8/22/99	8	105	111	88	95	100
8/24/99	19	103	93	70	86	96
8/26/99	7	83	92	55	83	81
8/28/99	44	60	86	52	70	79
8/30/99	12	60	86	50	68	75
9/01/99	13	54	77	49	67	71
9/03/99	18	54	73	45	65	66
9/05/99	9	53	73	38	64	63
9/07/99	17	52	70	34	61	61
9/09/99	28	52	70	31	59	51
9/11/99	13	--	--	--	--	--
9/13/99	23	--	--	--	--	--
9/15/99	23	--	--	--	--	--
9/18/99	13	--	--	--	--	--
9/19/99	12	--	--	--	--	--

* The NAAQS for 24-Hour TSP, when in place, was 260 $\mu g/m^3$. Maine's standard was 150 $\mu g/m^3$.

top ten 24-hour TSP values at that site exceeded the highest 24-hour TSP value experienced during the course of this study. Based on a comparison of TSP levels monitored at this site in 1999 with levels monitored in 1983 (prior to conversion of Schiller Station to coal), ambient TSP levels have improved significantly during the last 16 years.

[18] The source of the Eliot ME TSP values is a report generated in 1986 by Normandeau Associates, in accordance with permit conditions for Schiller Station. The values given in this table are for the ten highest monthly high values, August 1983 to July 1984, for 24-Hour TSP concentrations.

4.2. Sulfur Dioxide (SO_2)

Sources of SO_2 include virtually all fossil fuel burning devices, from lawn mowers to utility boilers. The most significant sources of SO_2 are large combustion devices that are fueled by high sulfur fuels, such as coal, residual oil (No. 6 oil, No. 4 oil), and distillate oil (No. 2 fuel oil, diesel fuel for off-road uses). Federal National Ambient Air Quality Standards (NAAQS) for SO_2, as well as those for New Hampshire and Maine, are listed in Table 4.2.

Table 4.2 – Applicable Sulfur Dioxide (SO_2) Standards

Jurisdiction	3-Hour Average SO_2 Standard (ppb)	24-Hour Average SO_2 Standard (ppb)	Annual Arithmetic Mean SO_2 Standard (ppb)
Federal NAAQS	500	140	31
New Hampshire	500	140	31
Maine	439	88	22

Sulfur dioxide concentrations were monitored continuously during this study at the site where TSP samples were collected on Spinney Creek Peninsula. The daily high 3-hour average and 24-hour average SO_2 levels monitored at the Eliot, Maine, and at some other monitoring stations in New Hampshire, during the study period are documented in Table 4.3.

The highest 3-hour average SO_2 level monitored at the Eliot, Maine site during this study was 55 ppb (11% of the 3-hour average SO_2 NAAQS). The highest 24-hour average SO_2 level monitored was 13 ppb (9% of the 24-hour average SO_2 NAAQS). For reference, Table 4.3 also provides SO_2 levels monitored during the same period for sites in Keene and Portsmouth (Vaughn Street).

Beyond comparing them to applicable standards, SO_2 levels were also monitored for the purpose of identifying conditions that would most represent the greatest expected PM impact of emissions from Newington and Schiller Stations[19] upon the Eliot area. The link between SO_2 readings and wind directions was instrumental in deciding what TSP and wipe samples were the best candidates for subsequent microscopy analysis by an independent laboratory.

[19] Appendix A provides graphs for each day of the study period, including hourly average SO2 and wind direction. 24-hour TSP samples were collected every two to three days, and therefore are not present on each graph.

Table 4.3 - Monitored Sulfur Dioxide (SO_2) Levels During Study Period

Date	Eliot ME		Portsmouth NH		Keene NH	
	Max 3-Hour Average (ppb)	24-Hour Average (ppb)	Max 3-Hour Average (ppb)	24-Hour Average (ppb)	Max 3-Hour Average (ppb)	24-Hour Average (ppb)
8/21/99	2	1	0	0	4	2
8/22/99	2	1	0	0	2	1
8/23/99	55	10	81	15	5	2
8/24/99	7	4	5	2	--	--
8/25/99	23	7	10	3	--	--
8/26/99	9	3	4	2	7	3
8/27/99*	2	2	0	0	3	2
8/28/99**	27	13	2	0	2	1
8/29/99	34	8	8	3	2	1
8/30/99	3	1	4	1	2	2
8/31/99	4	2	0	0	4	3
9/01/99	3	1	4	1	6	3
9/02/99	7	2	6	2	9	4
9/03/99	11	3	8	3	4	2
9/04/99	7	2	3	1	5	3
9/05/99	1	1	0	0	3	2
9/06/99	1	1	1	0	3	2
9/07/99	1	0	0	0	1	1
9/08/99	4	1	3	1	3	2
9/09/99	8	2	4	1	6	3
9/10/99	2	1	1	0	2	1
9/11/99	26	4	4	1	2	1
9/12/99	5	1	48	7	3	1
9/13/99	3	1	0	0	5	3
9/14/99	3	1	1	0	4	2
9/15/99	4	2	2	1	3	2
9/16/99	1	0	1	0	2	1
9/17/99	39	10	3	0	2	1
9/18/99	3	1	--	--	2	1
9/19/99	2	1	--	--	6	3
Maximum Level	**55**	**13**	**81**	**15**	**9**	**4**
Federal NAAQS	**500**	**140**	**500**	**140**	**500**	**140**
Max % of NAAQS	**11%**	**9%**	**16%**	**11%**	**2%**	**3%**

A blank entry indicates that the monitor was either down or being serviced on that day.
See Appendix A for detailed wind direction data.
* Days when a coal shipment was received.
** Days when a coal shipment was received and wind was generally from the west.

4.3. Surface Wipe Samples

Wipe samples were collected on most occasions that a DES operator visited the site. The purpose of this collection technique was to assess particle deposition similar to that experienced at residences in the immediate area, such as deposition on lawn furniture and parked vehicles. This type of sampling is not a common procedure for the measurement of air pollution, and the information derived from it is strictly qualitative. Detail for each wipe sample is provided in Table 4.4. Microscopic analysis of selected wipe samples, which provides some limited detail on the composition of the particulate matter, is discussed in Section 5.

Table 4.4 – Wipe Sample Log and Descriptions

Sample ID Number	Wipe Sample Location Description*	Site Operator	Observed Relative Level of Deposition	Color Description of Deposition
082399-1	Platform Target	PAS	Light	Brown
082599-1	Platform Target	PAS	Light	Brown
082999-1	Platform Target	PAS	Moderate	Black
082999-2	Platform Random	PAS	Moderate	Black
083199-1	Platform Target	PAS	Light	Black/Brown
083199-2	Platform Random	PAS	Light	Black
090299-1	Platform Target	PAS	Light	Black/Brown
090499-1	Platform Target	PAS	Light	Brown
090699-1	Platform Target	PAS	Clean	Clean
090699-2	Platform Random	PAS	Light	Black
091499-1	Platform Target	PAS	Light	Black
091699-1	Platform Target	LLL	Clean	Clean
092099-1	Platform Target	PAS	Light	Brown

* "Platform Target" refers to a marked area of the platform surface. "Platform Random" indicates that the operator chose another area on the platform to collect a sample in addition to the specified target area.

The wipe samples themselves simply indicate the presence or absence of particulate matter on the platform surface. Whereas the TSP sampler is equipped with a timer for 24-hour sampling, a given wipe sample is an aggregate of particulate deposition for the period since the last site visit (Sample ID Number corresponds to the date the sample was collected). The "Observed Relative Level of Deposition" from Table 4.4 is a qualitative visual assessment, made by the site operator, of the presence of particulate matter on the platform surface. The descriptor "Clean" means that there was no visible deposition on the sample area of the platform; "Light" means that there was a slightly visible accumulation of particulate matter on the platform surface; "Moderate" means that there was visible deposition on the platform surface, with a much higher area of the platform visible in the target area than covered by particulate matter; "Heavy" (which was not encountered during this project) means that there was visual deposition of scattered particles, with more area of the surface covered with PM than that which was clearly visible. "Color Description of Deposition" is also a qualitative visual assessment of the color of particulate matter on the platform.

The surface of the platform was set flat and level, roughly three feet from the ground. The platform remained exposed to the atmosphere for the length of the study and was cleaned off periodically in order to document the accumulation rate of material on the platform surface. Overall, PM collected in this manner is typically larger and/or more dense than that collected by the TSP sampler. The smaller, finer fraction of airborne PM tends to stay airborne longer and is less likely to settle onto exposed surfaces.

5. ADDITIONAL ANALYSIS AND REVIEW

5.1. Operating Schedule of Newington and Schiller Stations

Schiller Station's annual capacity factor (CF) is approximately 56%. This means that it only runs roughly half the time over the course of a year. When it does run, however, it typically generates at full capacity. Schiller Station can be fueled by either coal or residual oil (see Section 1.2.). During the study period, the primary fuel used was coal; only small amounts of residual oil were used. Schiller Station was functioning at full capacity for virtually the entire period that air monitoring data was collected for this study (August 22, 1999 through September 19, 1999).

Newington Station is a "peaking" power generation facility, with a CF of approximately 40%. It is dispatched on an "as needed" basis to respond to varying electric demand in the Northeast. This facility was designed as a peaking facility, and can operate on residual oil or natural gas. With high electricity demand in the late summer months, Newington Station was operating most days during this study. Table 5.1 provides a listing of the operating schedule for Newington Station[20] during the period when air monitoring data was collected for this study (August 22 through September 19).

5.2. Concentration of Certain Metals In TSP Samples

As part of this study, DES's Laboratory analyzed the concentration of certain elemental metals present in the TSP samples collected. The metals analyzed were: Antimony (Sb), Cadmium (Cd), Chromium (Cr), Manganese (Mn), Mercury (Hg)[21], Nickel (Ni), Vanadium (V), Zinc (Zn). Other metals tested for, but for which no detections were found were: Arsenic (As), Beryllium (Be), Cobalt (Co), Copper (Cu), Molybdenum (Mo), Silver (Ag), Thalium (Tl), and Uranium (U).

Table 5.2 provides the results of the metals analyses, and comparison to the corresponding New Hampshire and Massachusetts AALs. There were no exceedances of the New Hampshire or Massachusetts AALs for any of the metals analyzed as part of this study. There are no federal Ambient Air Limits (AALs) for these metals. The State of Maine also has no AALs for these metals. During the project planning phase, DES had hoped to, by analyzing for metals to the

[20] Information for Newington Station operation schedule was drawn from a review of the Continuous Emissions Monitor (CEM) data for that facility.

[21] Analysis for mercury concentrations was performed by DES Laboratories using Inductively Coupled Plasma/Mass Spectrometry (ICP/MS) on particulate matter collected on quartz filters. However, mercury is typically emitted in gaseous form, mercury levels are more accurately measured in rainwater samples using Cold Vapor Atomic Fluorescence (CVAP), a method which accommodates a lower detection limit. DES Laboratories does not have CVAP capabilities. The extent to which mercury is present in wet deposition particulate matter is not well defined. DES provided ICP/MS analyses of mercury in the TSP samples as a best effort initiative.

extent practicable, identify the source(s) of certain PM. However, this methodology did not provided significant insight into source attribution for the PM collected in TSP samples.

Table 5.1 – Operating Schedule for Newington Station During Study

Start Up		Shut Down	
Date	**Time**	**Date**	**Time**
8/22/99	DNR*	8/22/99	DNR
8/23/99	1:59 AM	8/23/99	10:00 PM
8/24/99	4:59 AM	8/24/99	9:00 PM
8/26/99	6:59 AM	8/26/99	6:00 PM
8/27/99	3:59 AM	8/27/99	10:00 PM
8/28/99	7:59 AM	8/28/99	11:00 PM
9/01/99	3:59 AM	9/01/99	9:00 PM
9/02/99	6:59 AM	9/02/99	10:00 PM
9/03/99	3:59 AM	9/03/99	10:00 PM
9/04/99	4:59 AM	9/04/99	9:00 PM
9/05/99	6:59 AM	9/05/99	9:00 PM
9/07/99	2:59 AM	9/09/99	10:00 PM
9/10/99	4:59 AM	9/10/99	10:00 PM
9/11/99	6:59 AM	9/11/99	9:00 AM
9/13/99	9:59 AM	9/13/99	1:00 PM
9/14/99	12:59 AM	9/14/99	9:00 PM
9/15/99	1:59 AM	9/15/99	10:00 PM
9/16/99	3:59 AM	9/16/99	10:00 PM
9/17/99	3:59 AM	9/17/99	10:00 PM
9/19/99	DNR	9/19/99	DNR

* DNR – Did Not Run. Periods not included in this table were also DNR.

Table 5.3 provides a list of some sources for metals detected in particulate matter samples. However, the number of potential sources for most of the metals analyzed makes it impossible to attribute particles to specific sources based solely on the presence of the individual metals.

5.3. Microscopy Analysis of TSP Samples

Two TSP filter samples were forwarded to an independent laboratory, Severn Trent Laboratories of Billerica, MA, for microscopy analysis. A copy of the report provided by Severn Trent Laboratories is provided in Appendix B. The TSP samples chosen for microscopy analysis were collected on August 28, 1999 and on September 5, 1999. The samples selected for analysis were chosen based on the presence of particulate matter on the filter, wind direction, and monitored SO_2 levels. The August 28 sample was chosen because it represented a worst case impact from Newington and Schiller Stations, as PSNH was receiving a shipment of coal, and the wind direction was consistent with greatest impact from Newington and Schiller Stations (i.e.,

Table 5.2 – Concentrations of Certain Metals in TSP Samples

Sample Information		Concentration Of Metals In TSP Samples (ug/m^3)									
Sample Number	Date	Vanadium (V)	Chromium (Cr)	Manganese (Mn)	Nickel (Ni)	Zinc (Zn)	Cadmium (Cd)	Antimony (Sb)	Barium (Ba)	Lead (Pb)	Mercury (Hg)[20]
Q7621628	08/22/99	0.003	0.002	0.002	0.001	0.010	0.000	0.000	0.003	0.003	0.000
Q7621629	08/24/99	0.007	0.001	0.005	0.003	0.036	0.000	0.001	0.008	0.030	0.000
Q7621630	08/26/99	0.008	0.001	0.005	0.004	0.020	0.000	0.001	0.010	0.009	0.000
Q7621632	08/28/99	0.080	0.001	0.003	0.011	0.014	0.000	0.000	0.005	0.004	0.000
Q7621633	08/30/99	0.002	0.001	0.004	0.002	0.005	0.000	0.000	0.003	0.002	0.000
Q7621634	09/01/99	0.007	0.001	0.008	0.002	0.020	0.000	0.000	0.008	0.010	0.000
Q7621635	09/03/99	0.014	0.001	0.002	0.006	0.026	0.001	0.001	0.009	0.007	0.000
Q7621644	09/05/99	0.003	0.001	0.002	0.003	0.005	0.000	0.000	0.002	0.001	0.000
Q7621645	09/07/99	0.003	0.001	0.003	0.003	0.010	0.000	0.000	0.005	0.002	0.000
Q7621646	09/09/99	0.007	0.001	0.004	0.004	0.032	0.000	0.001	0.007	0.006	0.000
Q7621647	09/11/99	0.002	0.001	0.004	0.001	0.021	0.000	0.000	0.004	0.005	0.000
Q7621648	09/13/99	0.006	0.001	0.003	0.002	0.015	0.000	0.000	0.006	0.004	0.000
Q7621649	09/15/99	0.008	0.001	0.003	0.001	0.016	0.000	0.000	0.007	0.004	0.000
Q7621673	09/19/99	0.003	0.001	0.002	0.002	0.018	0.000	0.000	0.003	0.006	0.000
Maximum Level (ug/m^3)	--	0.080	0.002	0.008	0.011	0.036	0.001	0.001	0.010	0.030	0.000
NH 24 hr AAL (ug/m^3)	--	NA[22]	1.8	1.0	3.6	25.0	0.036	1.8	2.5	0.18	0.3
MA 24 hr AAL (ug/m^3)	--	0.27	1.4	NA	0.27	NA	0.003	NA	NA	0.14	0.14

generally from the west). The sample from September 5, 1999 was chosen as a comparative sample. The predominant wind for the day was from the direction of the Interstate 95 corridor and downtown Portsmouth (southeast), and less so from the direction of Newington and Schiller Stations. Both facilities were operating on August 28 and September 5.

Table 5.4 summarizes the findings of the independent laboratory's microscopy analysis of the TSP samples. Microscopic analysis is performed using a given number of particles taken from the sample (in this case 100), and therefore the overall particle density (or number of particles, and thus the appearance of the sample) does not influence the findings. The distributions are given by weight and by particle number count.

[22] New Hampshire has Ambient Air Limits (AALs) for all metals listed as Hazardous Air Pollutants (HAPs) by EPA, and for metals for which the American Conference of Governmental and Industrial Hygienists (ACGIH) has established occupational exposure limits. Vanadium is not listed by either EPA or ACGIH and therefore is not listed by New Hampshire at this time. New Hampshire does have an AAL for vanadium pentoxide (V_2O_5) of 0.179 ug/m^3.

Table 5.3 – Sources of Metals in Particulate Matter[23]

Metal	Symbol	Sources
Vanadium	(V)	Residual oil combustion, coal combustion, smelter fine, incinerators, antimony roasters, sea salt
Chromium	(Cr)	Residual oil combustion, coal combustion, motor vehicles, natural soil, agricultural soil, construction, paved road dust
Manganese	(Mn)	Motor vehicles, agricultural soil, paved/unpaved road dust, coal combustion, smelter fine, incinerators, antimony roasters, vegetative burning, lake bed, natural soil, construction
Nickel	(Ni)	Residual oil combustion, coal combustion, motor vehicles
Cadmium	(Cd)	Smelter fine
Antimony	(Sb)	Antimony roaster, smelter fine
Barium	(Ba)	Coal combustion, residual oil combustion, paved/unpaved road dust, motor vehicles, natural soil, agricultural soil, construction, lake bed, sea salt
Lead	(Pb)	Residual oil combustion, smelter fine, incinerators, motor vehicles, coal combustion, antimony roaster, sea salt, vegetative burning, paved road dust
Mercury	(Hg)	Residual oil combustion, coal combustion, incinerators

5.3.1. Particle Distribution - TSP Sample from August 28, 1999

The findings of the microscopy analysis on the August 28 TSP sample illustrate that coal dust was the main component of the total suspended particulate matter in this sample. This is not surprising since a shipment of coal was being delivered to Schiller Station during this time, and the predominant wind during this day was consistent with greatest impact from Newington and Schiller Stations (i.e., generally from the west). Both facilities were operating on August 28. Coal ash and oil soot were detected in substantially lower concentrations. The remainder of the sample consisted of mineral matter (i.e., crustal material), biologicals, ambiguous soots and vehicle soot, which are described by Severn-Trent Laboratories (the independent lab contracted for microscopy analysis of TSP and surface wipe samples) as "typical outdoor dust particles." The distribution of particulate matter analyzed by weight can be skewed by variations in particle sizes and densities, as in the case of the biological component in this sample. Though biologicals represent only 9% of the number of particles, they represent 29% of the weight. Figure 5.1 provides a graphical representation of the particle distribution by particle number count for this sample.

[23] Sources of metals in particulate matter were derived from a technical paper appearing in the Volume 45, May 1995 edition of the *Journal of the Air & Waste Management Association* entitled "Measurement Methods to Determine Compliance with Ambient Air Quality Standards for Suspended Particles," prepared by Judith C. Chow, Desert Research Institute, University and Community College System of Nevada, Reno, NV. The article detailed an evaluation of a study of laboratory analyses of particulate matter from known anthropogenic and natural sources.

Table 5.4 – Microscopy Analysis of TSP Samples

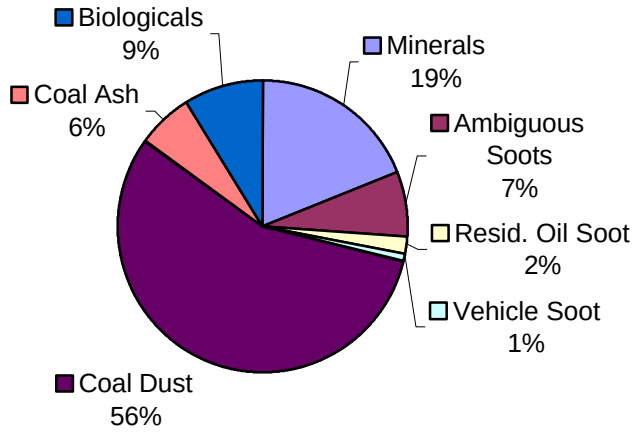
Particle Types and Specific Gravities	Sample Q7621632 August 28, 1999 (wind generally from west)*			Sample Q7621644 September 5, 1999 (wind generally from southeast)*		
	Particle Quantity (%)**	Particle Weight (%)	Mean Diameter (µM)	Particle Quantity (%)**	Particle Weight (%)	Mean Diameter (µM)
Minerals (crustal) (S.G. = 2.7)	19	20	8	48	34	9
Ambiguous Soots (S.G. = 1.1)	7	4	9	16	1	6
Oil Soot (S.G. = 1.1)	2	1	11	1	<1	10
Vehicle Soot (S.G. = 1.1)	1	<1	10	2	<1	8
Coal Dust (S.G. = 1.4)	56	44	10	4	<1	4
Coal Ash (S.G. = 2.7)	6	3	7	3	49	33
Biologicals (S.G. = 1.5)	9	29	11	26	15	8

* Wind directions vary over the course of a day. See Appendix A for more detailed wind direction data.

** A total of 100 particles per sample were analyzed using microscopy. As seen in the variation in the proportion between particle quantity and particle weight with coal ash, particle size and density may skew weight distribution of particles.

Figure 5.1 – Particle Distribution By Type In TSP Sample Q7621632 (August 28, 1999)

Data Source: Severn Trent Laboratories Microscopy Analysis of TSP Sample Q7621623
(See Table 5.4 and Appendix B)



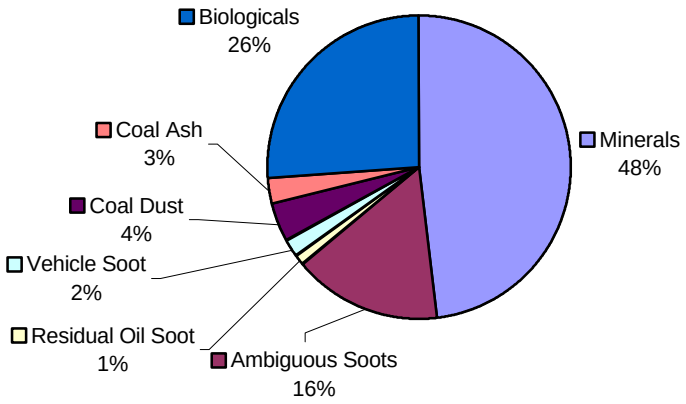
5.3.2. Particle Distribution - TSP Sample from September 5, 1999

The findings from the microscopy analysis on the September 5, 1999 TSP sample indicate low volumes of coal dust, coal ash, and oil soot. Those components which are described by Severn-Trent Laboratories as "typical outdoor dust particles" (mineral matter, biologicals, ambiguous soots and vehicle soot) account for most of the particles (92%) present in this sample. Coal ash particles account for only 3% of the particle count on this day. However, as with the biologicals component of the August 28 TSP sample, their particle size and density skew the weight distribution of the sample. Figure 5.2 provides a graphical representation of the particle distribution by particle count for this sample.

5.4. Microscopy Analysis of Wipe Samples

A total of four wipe samples were forwarded to an independent laboratory, Severn Trent Laboratories of Billerica, MA for limited microscopy analysis. A copy of the report provided by Severn Trent Laboratories is provided in Appendix B.

Figure 5.2 – Particle Distribution By Type In TSP Sample Q7621644 (September 5, 1999)
Data Source: Severn Trent Laboratories Microscopy Analysis of TSP Sample Q7621623
(See Table 5.4 and Appendix B)



Wipe samples selected for analysis were chosen based on the presence of particulate matter on the platform surface, wind direction, monitored SO_2 levels, and evidence of particulate matter on the corresponding TSP filter. Table 5.5 summarizes the findings of the independent laboratory's microscopy analysis for the wipe samples. The Sample ID Number corresponds to the date the sample was collected. The corresponding TSP filter would be from a day or two prior to collection of the wipe sample. The TSP filters were exposed to particulate matter in a more controlled manner because the pump that draws air through the monitor is on a timer set for 24 hour segments (midnight to midnight). The platform is exposed the entire time between the taking of wipe samples, so it is possible that particulate matter present on the platform was deposited on a day when the TSP sampler was not in operation. Further, particulate matter on the surface of the platform is generally that which is dense enough to be deposited on a surface

rather than remaining airborne. Finer particulate matter, which is considered a greater threat to public health because of its ability to penetrate further into the human respiratory system via inhalation, is more likely to be present on the TSP filter than on the platform surface.

Wipe samples from August 29, 1999 and August 31, 1999 were selected based on the presence of visible particulate matter on both of the wipe samples, which was estimated to be the heaviest experienced during the course of the study. This was also the time during which PSNH was receiving a shipment of coal, and wind conditions were consistent with greatest impact from Newington and Schiller Stations. The sample from September 6, 1999 was chosen because the surface was described as "clean" by the site operator, and thus was a good choice for comparison to heavier deposition days. The predominant wind direction on the days associated with this wipe sample was from the east-southeast.

The microscopy analysis performed on the wipe samples is essentially a close look at 100 individual particles extracted from the sample. Only 100 particles are scrutinized whether there are 100 total particles on the sample or 10,000. Therefore, the findings are not necessarily influenced by a comparative amount of PM present on the sample surface. In short, the purpose of microscopy analysis is to help determine the likely character and composition of the PM on a sample filter, not the amount of PM on a sample filter.

Table 5.5 – Microscopy Analysis of Surface Wipe Samples*

Sample ID Number	Opaques**		Mineral Grains		Biologicals	
	% of Particles	Description of Particles	% of Particles	Description of Particles	% of Particles	Description of Particles
082999-1	80%	coal dust, oil soot, coal ash	15%	soil material	5%	spores, pollen
082999-2	95%	coal dust, oil soot, coal ash	4%	soil material	1%	spores, pollen
083199-2	90%	coal dust, oil soot, coal ash	3%	soil material	3%	spores, wood chips, vegetable matter, pollen
090699-1	80%	coal dust, coal ash, rubber dust	10%	soil material	10%	spores, pollen

* A total of 100 particles per sample are analyzed using microscopy.
** Opaques are particles which are impervious to light.

Microscopy analysis performed on the wipe samples was limited to describing percentages of opaques (particles impervious to light), mineral grains, and biologicals. Opaque particles found included coal dust, coal ash, oil soot, and rubber dust. Rubber dust was present on the sample taken from September 6, a day when the predominant wind direction was from the Interstate 95 corridor. Mineral grains, or airborne soil particles, and biological matter accounted for the remainder of the particles present on the wipe samples.

Oil soot was present in samples taken from August 29 and August 31, and was described by Severn Trent Laboratories as being from industrial grade fuel oil (residual oil). Schiller Station employs coal as its primary fuel, using only a small amount of residual oil in start-up functions. Newington Station uses residual oil (industrial grade fuel oil) as its primary fuel. However, as is detailed in Table 5.1, Newington Station was not operating during the period affecting the August 31 sample. There are a number of other stationary sources within the impact area, and at least one marine vessel was present in the area at this time, that burn residual oil. Further analysis, including stack testing at the source, would be necessary to attribute the oil soot to particular sources.

5.5. Visible Emissions from the Area of Newington and Schiller Stations

There are occasions when emissions from the stacks at Newington and Schiller Stations are visible. The visibility of stack emissions is measured in terms of percent opacity. The opacity of emissions from both Newington and Schiller Stations is continuously monitored by certified monitoring equipment. The New Hampshire Code of Administrative Rules (Part Env-A 2003) specifies regulatory limits for stack opacity. The regulation allows for short periods of elevated opacity (no more than 6 minutes per hour) for startup, shutdown, malfunction, and soot blowing.

Malfunctions and unusual events occur from time to time at these facilities, as they do at any large facility, and can result in short-term high opacity emissions. As an example, an upset condition at Newington Station in June resulted in an opacity excursion (100%) that lasted for several minutes. There are provisions in the operating permits of all facilities in New Hampshire which allow for such malfunctions, provided they are documented and reported in accordance with permit conditions. The New Hampshire Code of Administrative Rules requires that events of this kind be reported to DES, investigated by facility staff, and measures taken to prevent them from re-occurring. The impact that such an event would on the Eliot, Maine area is predicted to be relatively low (based on dispersion modeling) because of the height of the stacks and the dispersion characteristics of the emissions. Much of the PM would travel beyond the Eliot area and be dispersed in the air to the point where concentrations would be low.

Soot blowing is a normal, permitted periodic maintenance procedure whereby soot buildup on the boiler tubes is removed, typically using either steam or compressed air. This is necessary because soot buildup interferes with the heat transfer efficiency of the boiler, and less efficient boilers consume more fuel, leading to greater emissions. Soot blowing ensures the efficient, reliable operation of these facilities resulting in lower overall emissions. Because opacity is continuously monitored and reported, DES can determine violations of opacity permit conditions at Newington and Schiller Stations by reviewing quarterly emission reports.

DES has received occasional complaints from the Eliot, Maine area in the past in which visible smoke, odor and particulate episodes have been investigated. In some instances, the Newington and Schiller Stations have been identified as the source of a particular episode, and investigation of the complaint has confirmed that there was in fact an upset condition or unusual circumstance at one of the plants that led to high opacity emissions. In some cases, investigation has revealed that sources other than Newington and Schiller Stations have been responsible for the reported problem. There have been some complaints, particularly those relative to odors, that have never been resolved.

In June 1999, during the planning stages of this study, DES received a complaint from the Dixon Avenue area of Eliot, Maine which included several photographs taken on May 23, 1999 showing heavy black smoke that was described as coming from Schiller Station. The photographs in Appendix C show a cloud of heavy black smoke rising from behind a row of conifers which block the view of the New Hampshire side of the river. Closer scrutiny of the photographs revealed that the smoke could not have come from the stacks at the power plants, but apparently came from a vessel in the Piscataqua River. The New Hampshire Port Authority was contacted and was able to provide a monthly tally of vessels traversing the river, including their destinations, cargoes, arrival and departure dates, number of tugboats used to assist the vessel in navigating the river and vessel length. Using the information provided by the Port Authority, it was determined that a Liberian tanker, the "Kestrel," was offloading oil at the PSNH fuel pier (adjacent to Schiller Station) on May 23, 1999, when the photographs were taken. The pier location matches the location of the smoke in the photographs.

DES contacted PSNH regarding fuel offloading practices from vessels. Ships delivering residual oil are required to keep the oil at a certain temperature. The ship's their on-board boilers are used to maintain the temperature of the oil. PSNH is responsible for maintaining the temperature of the delivery line between the port and their storage facilities. The ship's pumps are used to offload the oil. Officials at PSNH indicate that it is company policy that when a vessel that is offloading fuel, be it coal or oil, is observed to have high opacity emissions while in port to deliver fuel, the captain of the vessel is immediately notified and instructed to shut down the activity generating the high opacity emissions while in port.

5.6. Marine Traffic in the Piscataqua River

Marine traffic along the Piscataqua River includes vessels ranging from small recreational watercraft to cargo ships several hundred feet long. Larger vessels require the assistance of tugboats. Emissions from marine vessels do not fall under the authority of individual states, and are completely unregulated with regard to the composition of the fuel (e.g., sulfur content). Whereas many stationary sources have some control equipment to curb emissions, ship emissions are typically uncontrolled and can operate with high-opacity emissions indefinitely. According to New Hampshire Port Authority reports, 17 vessels large enough to require assistance from tugboats and/or a harbor pilot passed through the river channel during the study period, resulting in 34 total passes. This data is limited to larger vessels, and does not provide insight on total marine traffic, (i.e., tugboat traffic and commercial/recreational craft that did not require assistance to pass through the river channel).

Marine traffic on the Piscataqua River discharges emissions closer to the Eliot, Maine area than any existing stationary sources. In addition, most of these discharge points are very close to ground level, creating the potential for greater impact on the Eliot area. The flow of the Piscataqua River bends to the east as it passes the Spinney Creek peninsula, and is constricted by land masses (i.e., rocky outcrops) on both banks, causing an amplification of current velocity near the monitoring site in Eliot. River currents in this area are also impacted by tidal flows. As a result, vessels passing this point in the river often must increase engine load to navigate through this section. Increased engine load results in increased uncontrolled emissions from the vessel. Additionally,

as many as three tugboats accompany larger vessels as they move up and down the river. Emissions from tugboats, which are generally diesel powered, were observed on one occasion during the study to be as high as 85% opacity for a period of several minutes while maneuvering a vessel in this section of the river.

Exhaust emissions from marine vessels while tied up in port offloading commodities at facilities along the river also contribute to the particulate load in the Eliot, Kittery and Portsmouth area. Observations made during and subsequent to this study indicate that vessels in port continue to operate boilers and diesel auxiliary power plants with resultant visible emissions as high as 100% opacity for extended periods of time. Unfortunately, these emissions sources are not under the regulatory jurisdiction of DES.

The extent to which emissions from marine traffic impact the Eliot, Maine area cannot be determined within the scope of this study. However, marine traffic is undeniably a significant contributing factor. Particle size can be an indicator of the combustion source. Marine boilers do not employ air pollution control devices, such as the electrostatic precipitators (ESPs) used in land-based utility boilers, to remove particulate matter from the exhaust. As a result, much larger particles are emitted directly to the atmosphere. More detailed analysis of emissions from known sources could possibly provide greater insight on the attribution of particles to specific sources.

While the dispersion models used for this study are not ideal for predicting the impact of mobile ship emissions, the modeling that was done qualitatively predicted that particulate matter impacts in the Eliot area may be greater from marine vessel emissions than from combustion sources at Newington and Schiller Stations because of comparative discharge heights, emission controls, and dispersion characteristics.

5.7. Other Potential Sources of Particulate Matter

The focus of this project was to study particulate matter in the vicinity of Eliot, Maine. Although Newington and Schiller Stations are common targets for complaints relative to air quality and particulate matter deposition in that area, there are a number of other sources that contribute to local particulate matter (and other air pollutant) concentrations. Source attribution requires intensive analysis which can be time consuming and costly. Nevertheless, this section provides a short discussion of other potential sources of air pollution impacting the Eliot, Maine area.

The area surrounding Eliot, Maine includes relatively dense development, which is typically accompanied by high levels of vehicular traffic and other population-based air pollution sources. Interstate 95, which is a major corridor for thousands of light- and heavy-duty vehicles every day, is only a short distance away (approximately 1.5 miles). Motor vehicles are the greatest single source category for many air pollutants, including nitrogen oxides (NOx), anthropogenic volatile organic compounds (VOCs), carbon monoxide (CO), and many toxics. On- and off-road vehicles, particularly those using diesel fuel, are also substantial sources of particulate matter from exhaust and from the generation of road and rubber dust. Area sources of air pollution, inventories for which are based largely on population, include a wide range of sources and pollutants. Unregulated emissions from residences, businesses and light industry, and open

burning of brush and building materials (both permitted and unpermitted) in the towns surrounding Eliot, also impact local air pollutant concentrations.

There are also a number of major stationary sources located in the vicinity of Eliot. Table 5.6 lists some of New Hampshire's stationary sources in this region.

Table 5.6 – Major NH Stationary Sources Proximal to Monitoring Site*

Facility	Device(s)	Heat Output of Device(s) (MMbtu/hour)	Fuel	Control Equipment	Distance to Monitoring Site	Direction to Monitoring Site***
Newington Station	Boiler 1	4,350	Residual Oil	ESP	0.7 mi	W
Schiller Station	Boiler 4 Boiler 5 Boiler 6	574 574 574	Coal or Residual Oil**	ESP, SCR	0.3 mi	W
Sprague Energy	Boiler 1 Boiler 2	33.5 25	Residual Oil	--	2.3 mi	NW
National Gypsum	Calciners (4) Board Kilns Rock Dryer	28 72 8	Distillate Oil	Bag Houses	0.8 mi	SE
E & W Roses	Boiler 1 Boiler 2 Boiler 3	27.6 15 15	Residual Oil	--	6.7 mi	NW
G.P. Gypsum	Calciners (3) Board Kilns	23 67	Natural Gas; Distillate Oil	Bag Houses	1.2 mi	W-NW
Simplex	Boiler 1 Boiler 2 Turbine	21 11.7 20	Natural Gas; Distillate Oil	--	1.0 mi	W-NW

* Although not detailed in this table because source specific information is unavailable, the Portsmouth Naval Shipyard (2.2 miles southeast of the monitoring site) is also a contributing stationary source.

** Schiller Station can fire either residual oil or coal. Coal was the primary fuel during the study period.

*** Direction from the source to the monitoring site.

6. CONCLUSIONS

6.1. General

This study of particulate matter concentrations in the Eliot, Maine area was conducted by the New Hampshire Department of Environmental Services (DES), in response to complaints about emissions from two New Hampshire electric power generation facilities. These facilities, owned and operated by PSNH, are located just across the state border (the Piscataqua River) from Eliot, Maine. DES reviewed and investigated all identifiable sources of particulate matter, conducted total suspended particulate (TSP) and sulfur dioxide (SO_2) monitoring and sampling, reviewed meteorological conditions and wind direction, used laboratory analyses to estimate TSP and certain elemental metal concentrations, performed dispersion modeling for particulate matter impacts from the PSNH plants, and contracted with an independent laboratory to conduct microscopy analyses to identify particle composition on representative particulate matter samples. The following conclusions can be drawn from the findings of these efforts.

6.2. Compliance with Ambient Air Quality Standards

The air quality parameters monitored as part of this study were TSP and SO_2. During the period of this study, air quality at the monitoring site was measured to be well in compliance with applicable state and federal standards for those parameters that were monitored.

6.2.1. Total Suspended Particulates (TSP)

A TSP monitor was used for this project. The TSP standard was replaced by the PM_{10} (airborne particles 10 microns or less in width) standard in 1988. Historical particulate matter air monitoring data available for this area was collected in the mid-1980s using TSP monitors, one of which was located in the same field used for this project. In addition, for the purposes of this study, it was desirable to capture the total fraction of airborne particulate matter for analysis. Because TSP monitors do not discriminate by particle size, any airborne particle is eligible for collection on the filter media. Although there is no existing National Ambient Air Quality Standard (NAAQS) for TSP (since the PM_{10} standard replaced the TSP standard), the former federal, New Hampshire, and Maine 24-hour average TSP standards were used for comparison (see Appendix A).

The highest 24-hour TSP concentration measured in this study occurred on August 28, 1999. The 24-hour TSP concentration for this sample was analyzed to be 44 $\mu g/m^3$. This value is well below the most recent federal and state TSP standards (260 $\mu g/m^3$ federal and New Hampshire, 150 $\mu g/m^3$ Maine). The ten highest TSP concentrations measured at the same site between August 1983 and July 1984 (prior to the conversion of Schiller Station to use coal) all exceeded 44 $\mu g/m^3$, with a maximum value of 100 $\mu g/m^3$ (see also Table 4.1). This finding suggests that particulate matter concentrations have improved significantly during the last 15 years.

6.2.2. Sulfur Dioxide (SO_2)

Typical SO_2 monitors do not distinguish the source of SO_2, thus it is not possible to derive the contribution of individual sources for even the relatively low values of SO_2 monitored during the course of this study. SO_2 was monitored continuously throughout the study period. There are three NAAQS for SO_2: a 3-hour average of 500 ppb, a 24-hour average of 140 ppb, and an annual arithmetic mean of 80 ppb. New Hampshire's SO_2 standards are identical to these federal standards. Maine's SO_2 standards are somewhat lower than federal standards, with a 3-hour average of 439 ppb, a 24-hour average of 88 ppb, and an annual arithmetic mean of 57 ppb.

The highest 3-hour average SO_2 level monitored during this study was 55 ppb, or 11% of the NAAQS (12.5% of Maine's SO_2 standard). The highest 24-hour average SO_2 level monitored during this study was 13 ppb, or 9% of the NAAQS (15% of the Maine standard).

Sources of SO_2 include virtually all fossil fuel burning devices from on-road vehicles to industrial boilers. In general, the most significant sources of SO_2 are large combustion devices that are fueled by high sulfur fuels, such as coal, residual oil (No. 6 oil, No. 4 oil), and distillate oil (No. 2 fuel oil, diesel fuel for off-road uses). However, many applications for use of the same types of fuel (such as marine vessels and diesel-powered construction equipment, heavy-duty vehicles, and off-grid power generation) are completely uncontrolled.

6.2.3. Certain Elemental Metals

As part of this study, DES's Laboratory analyzed the concentration of certain elemental metals from the TSP samples collected. The metals analyzed for which detectable levels were found in one or more samples include: Antimony (Sb), Cadmium (Cd), Chromium (Cr), Manganese (Mn), Nickel (Ni), Vanadium (V), Zinc (Zn). Other metals tested for, but for which no detections were found include: Arsenic (As), Beryllium (Be), Cobalt (Co), Copper (Cu), Mercury (Hg)[24], Molybdenum (Mo), Silver (Ag), Thalium (Tl), and Uranium (U). There were no exceedances of the New Hampshire and Massachusetts Ambient Air Limits (AALs) for any of these metals. There are no federal or State of Maine AALs for any of these metals.

6.3. Meteorology and Emissions Discharge Points

Meteorology plays a major role in the level of air pollution measured at a given point and time. Wind direction, wind speed, and precipitation also affect the impacts of emissions from any source (or sources) upon a given point. Often, predominant historical meteorology patterns influence certain permit conditions for major sources, such as the required discharge points (e.g., stack height).

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[24] Analysis for mercury concentrations was performed by DES Laboratories using Inductively Coupled Plasma/Mass Spectrometry (ICP/MS) on particulate matter collected on quartz filters. However, mercury is typically emitted in gaseous form, mercury levels are more accurately measured in rainwater samples using Cold Vapor Atomic Fluorescence (CVAP), a method which accommodates a lower detection limit. DES Laboratories does not have CVAP capabilities. The extent to which mercury is present in wet deposition particulate matter is not well defined. DES provided ICP/MS analyses of mercury in the TSP samples as a best effort initiative.

Spinney Creek Peninsula is proximal to a variety of emissions sources in addition to PSNH's Newington and Schiller Stations, including other major stationary sources, mobile sources (including a heavily-traveled section of Interstate 95), uncontrolled ocean-going marine traffic, and population-based sources characteristic of development in the area. Analysis of the particulate matter concentrations and composition from samples collected during this study suggests that deposition impacts in the Eliot area, while substantially below applicable federal and state health-based standards, are greatest when there are significant coal handling activities (i.e., those which generate coal dust) occurring at Schiller Station and the predominant wind direction is generally from the west (i.e., from the direction of that facility). Dispersion modeling conducted as part of this study affirms this conclusion.

6.4. Airborne Particulate Matter Concentrations and Deposition

An impact study conducted in 1981 by the consulting firm Environmental Research & Technology, Inc. (ERT) in conjunction with the planned conversion to coal at Schiller Station concluded that the greatest particulate matter impact downwind from that facility would be from coal dust generated by activities associated with the delivery and handling of coal. Modeling performed as part of this study reached the same conclusion. TSP monitoring and analysis verifies that when coal handling activities are high, and the predominant wind direction is from the west, coal dust was the primary component of airborne particulate matter. When coal handling activities were more routine and/or wind direction was not from the west, the majority of the airborne particulate matter could be described as "typical outdoor dust particles" (mineral matter, biologicals, ambiguous soots[25], vehicle soot, crustal matter, etc.).

The dispersion modeling, and TSP monitoring and analysis, leave little doubt that complaints of "soot deposition" in the Eliot, Maine area are principally due to uncombusted coal dust. Greatest deposition of coal dust in the Eliot, Maine area appears to correspond to days where coal handling activities at Schiller Station are high and meteorological conditions (i.e., winds generally from the west and no precipitation) are consistent with greatest impact to the Eliot, Maine area from that facility. Dispersion modeling performed as part of this study does not predict significant particulate matter impacts from post-combustion stack emissions from Newington or Schiller Stations upon the Eliot area. In fact, this modeling predicts that particulate matter impacts in Eliot, Maine from stack emissions at Newington and Schiller Stations are on the same order of magnitude as from marine vessels, due to the relative proximity of these sources and the lower elevation of their emissions discharge points.

6.5. High Opacity Emissions Visible from Spinney Creek Peninsula

Newington and Schiller Stations are the most visible stationary sources from much of the Spinney Creek Peninsula area. Concerns relative to air quality in the Eliot area are heightened when high opacity emissions are witnessed in the vicinity of the exhaust stacks at these facilities. Short term episodes of high opacity emissions do occur at these facilities, usually consistent with permit conditions (e.g., periodic soot blowing) and occasionally in malfunction episodes

[25] Ambiguous soots are miscellaneous soots which cannot be attributed to a specific combustion source or source category and are not necessarily limited to fossil fuel combustion.

requiring plant operational adjustments. Dispersion modeling and particulate matter monitoring conducted as part of this study confirm that, because of the discharge point and dispersion characteristics of these emissions, short-term high opacity emissions from the exhaust stacks at these facilities do not have a significant impact on air quality in the Eliot area.

Another source of high opacity emissions visible from the Spinney Creek Peninsula area is marine vessels. These vessels may be underway on the Piscataqua River or in port along the river and firing to meet on-board heating or power loads. For example, DES received one complaint in May 1999 accompanied by a photograph of high opacity emissions in the vicinity of Schiller Station. Closer investigation revealed that the emissions in the photograph were actually coming from a ship docked at PSNH's pier. The Piscataqua River channel is relatively narrow, and is subject to strong tidal currents. Large vessels, and the tugboats which assist in their safe passage, often operate under high engine loads to negotiate the channel, sometimes generating high opacity emissions. Ships on the river can travel quite close to the Spinney Creek Peninsula shoreline, with low-elevation, uncontrolled emissions discharges.

Unfortunately, emissions from marine vessels do not fall under the regulatory jurisdiction of either New Hampshire or Maine. In fact, they are essentially unregulated, and should be revised at the federal and international levels.

6.6. Compliance Status of Newington and Schiller Stations

Newington and Schiller Stations are permitted stationary sources in New Hampshire. A review of the permit and compliance history of these facilities indicates that both facilities are now, and have been, operating in compliance with all New Hampshire and federal air pollution laws and regulations. There are no regulations in place at the present time, either at the state or federal level, which require additional emissions reductions from those facilities.

Apart from the focus of this study, but significant to the issue of air quality in the seacoast region, NOx[26] emissions from Schiller Station are limited by New Hampshire's NOx RACT[27] regulation. Specifically, its boilers are limited to an emission limit of 0.5 lbs NOx/mmBTU (pounds of NOx per million BTUs of heat input). Schiller achieved compliance with this emission limit by means of burner modifications. In addition, in 1999 Schiller Station voluntarily installed selective non-catalyst reduction (SNCR) controls on all three of its primary boilers to further reduce NOx emissions by 40-50% (down to approximately 0.25 lbs NOx/mmBTU). The installation of this equipment has resulted in greater reductions in NOx emissions from Schiller Station than is required by state and federal regulation. New Hampshire has achieved greater NOx reductions from its utility sources than any other state in the Northeast Ozone Transport Region as measured against its 1990 baselines.

[26] NOx represents nitrogen oxides, a product of combustion which is the limiting agent in the formation of ground level ozone in most areas of the U.S.

[27] The establishment of NOx RACT (Reasonably Available Control Technology) is required by the federal Clean Air Act. See the New Hampshire Code of Administrative Rules, Part Env-A 1211.

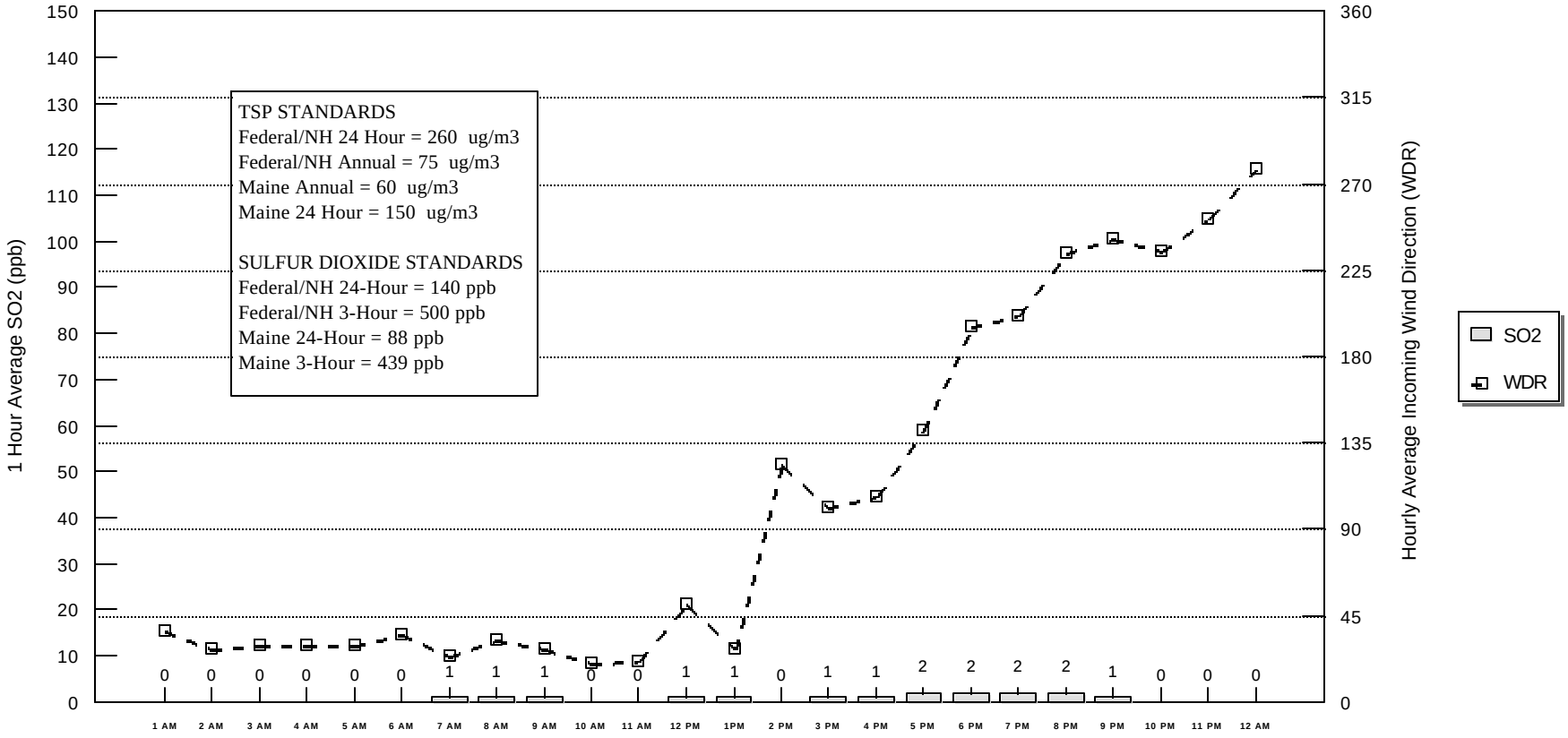
APPENDIX A

Graphs

Hourly SO2 Averages
Wind Direction
TSP Concentrations

Ambient Air Monitoring Special Project - Eliot, Maine

August 22, 1999 - 24-hour TSP Concentration = 0 ug/m3



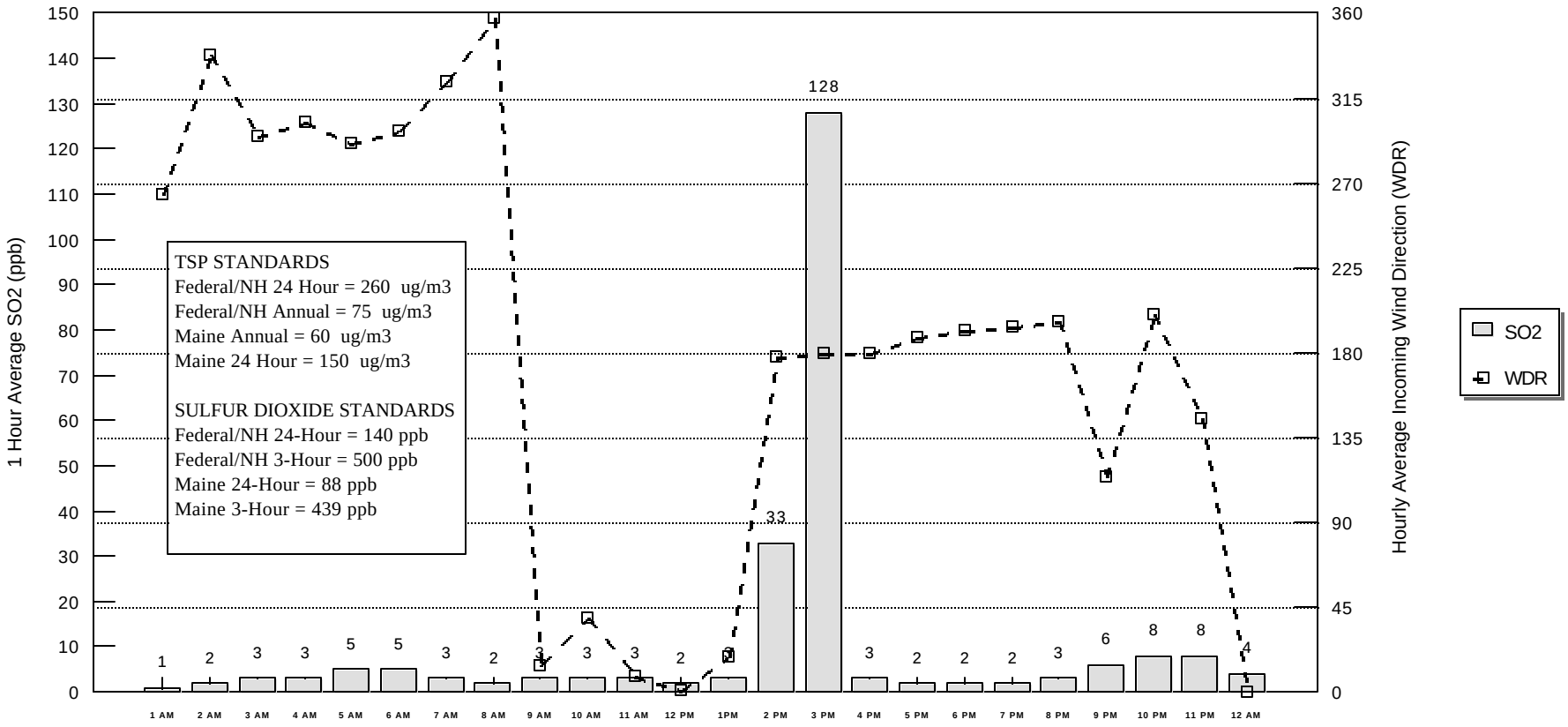
Max 3-Hour SO2 Avg. = 2 ppb 24 Hour SO2 Avg.= 1 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME

August 23, 1999 - no TSP sample collected



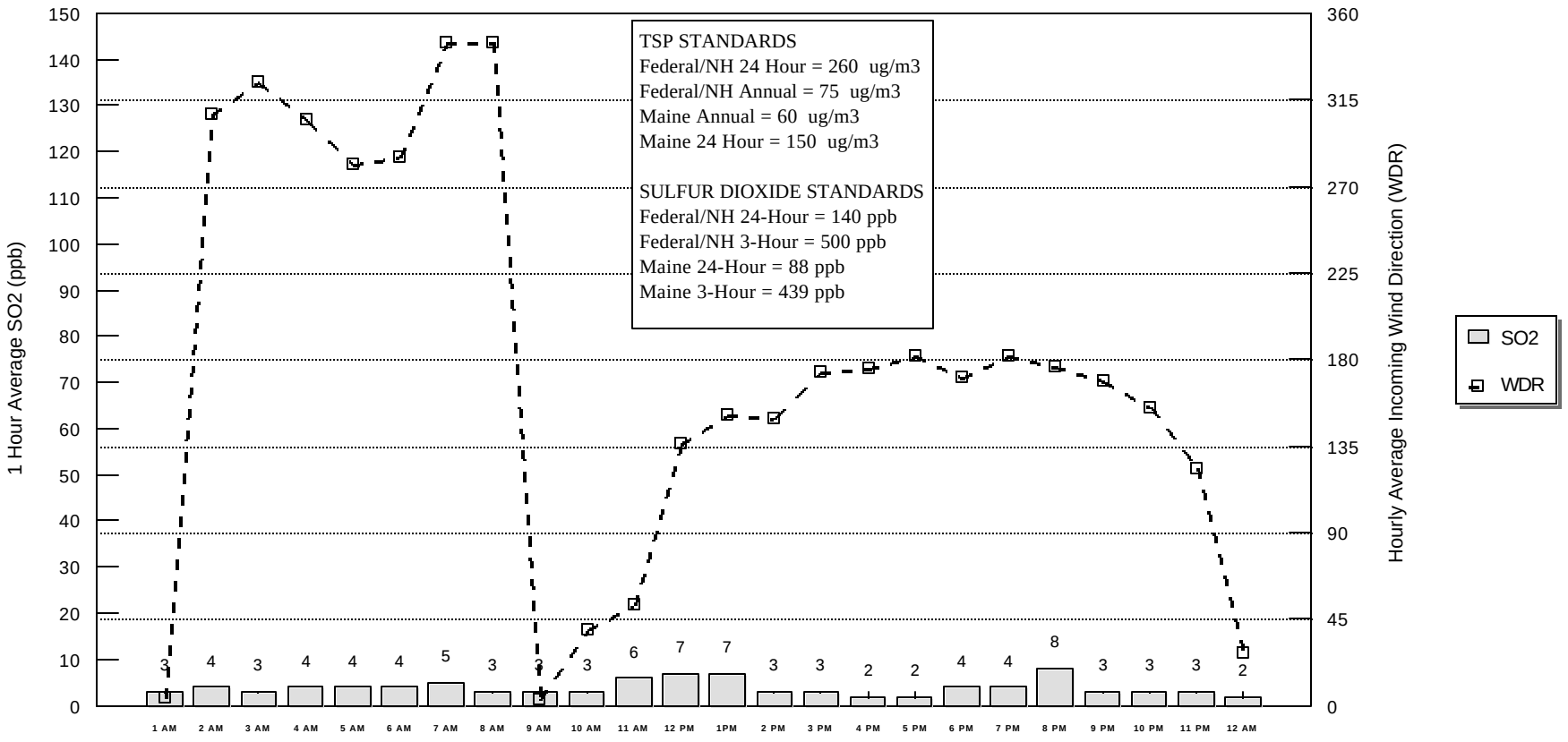
Max 3-Hour SO2 Avg. = 55 ppb 24 Hour SO2 Avg.= 10 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME

August 24, 1999 - 24-hour TSP Concentration = 19 ug/m3



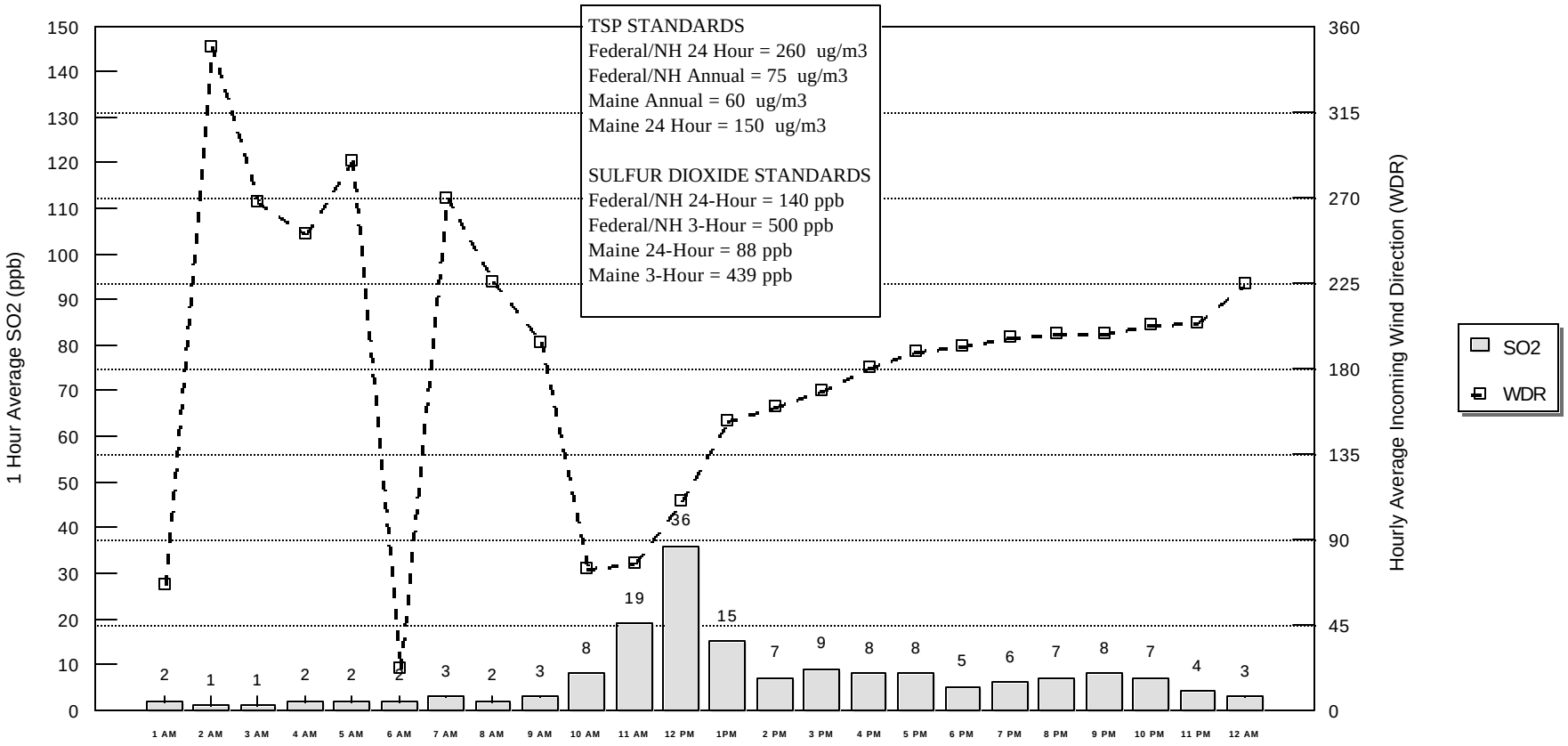
Max 3-Hour SO2 Avg. = 7 ppb 24 Hour SO2 Avg.= 4 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME

August 25, 1999 - no TSP sample collected

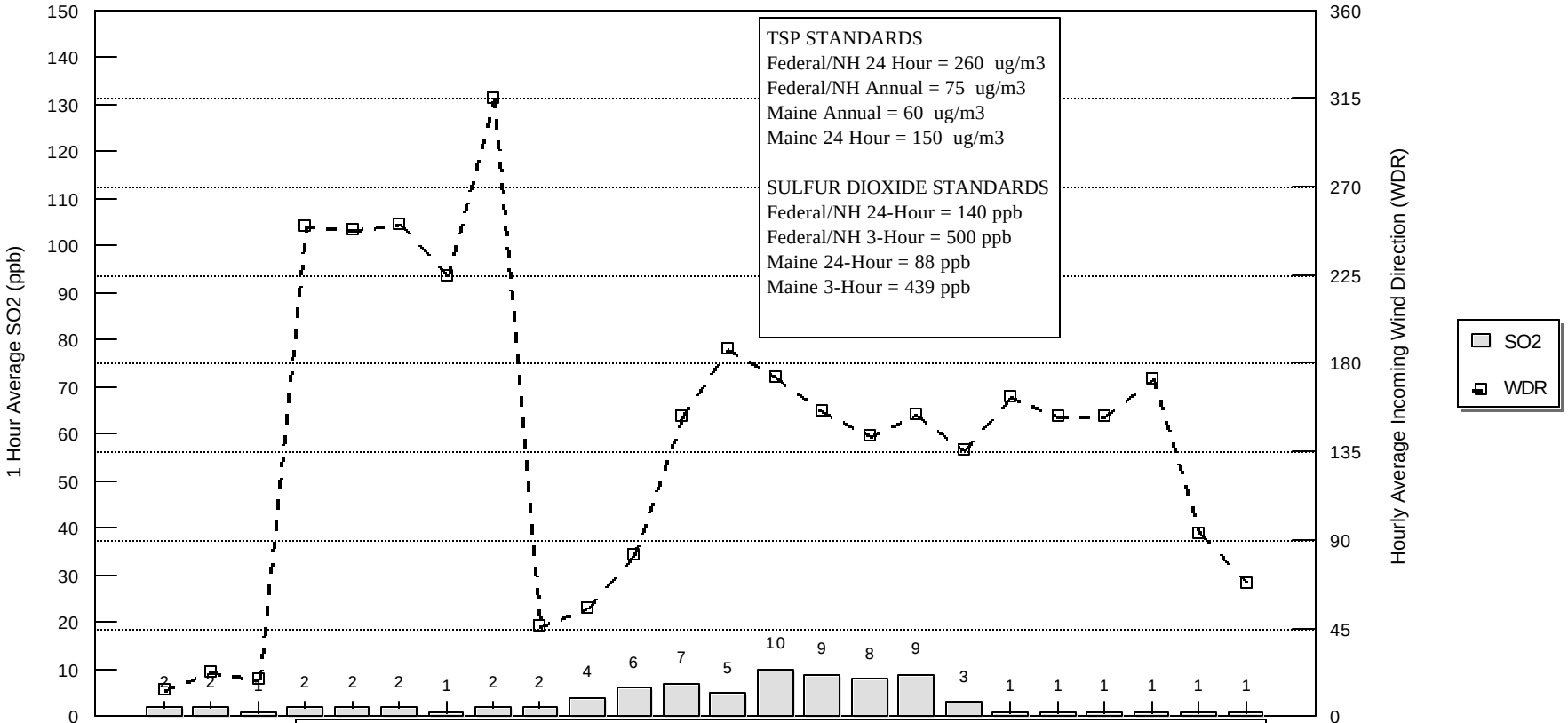


Max 3-Hour SO2 Avg. = 23 ppb 24 Hour SO2 Avg.= 7 ppb
ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

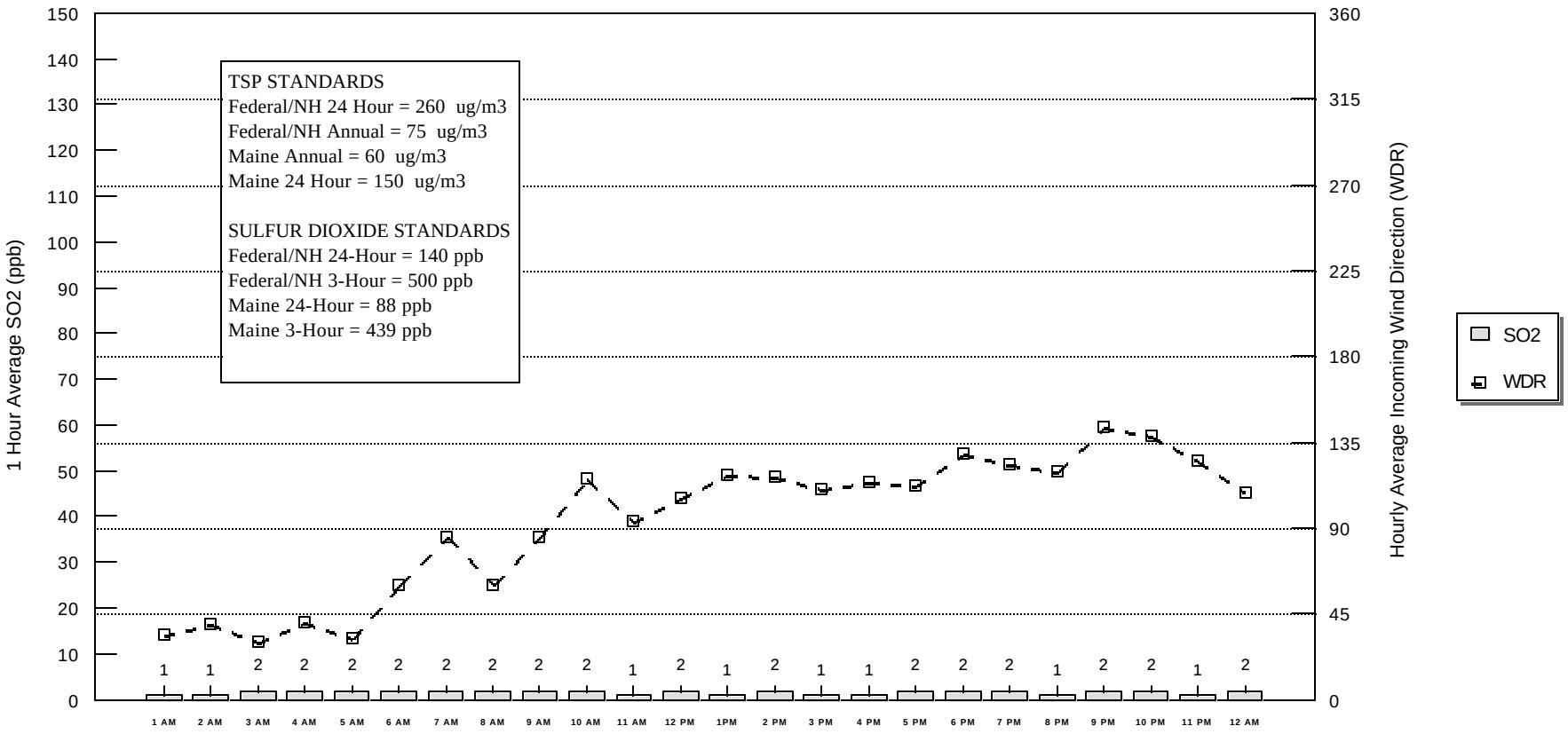
Ambient Air Monitoring Special Project - Eliot, ME

August 26, 1999 - 24-hour TSP Concentration = 7 ug/m3



Ambient Air Monitoring Special Project - Eliot, ME

August 27, 1999 - no TSP sample collected



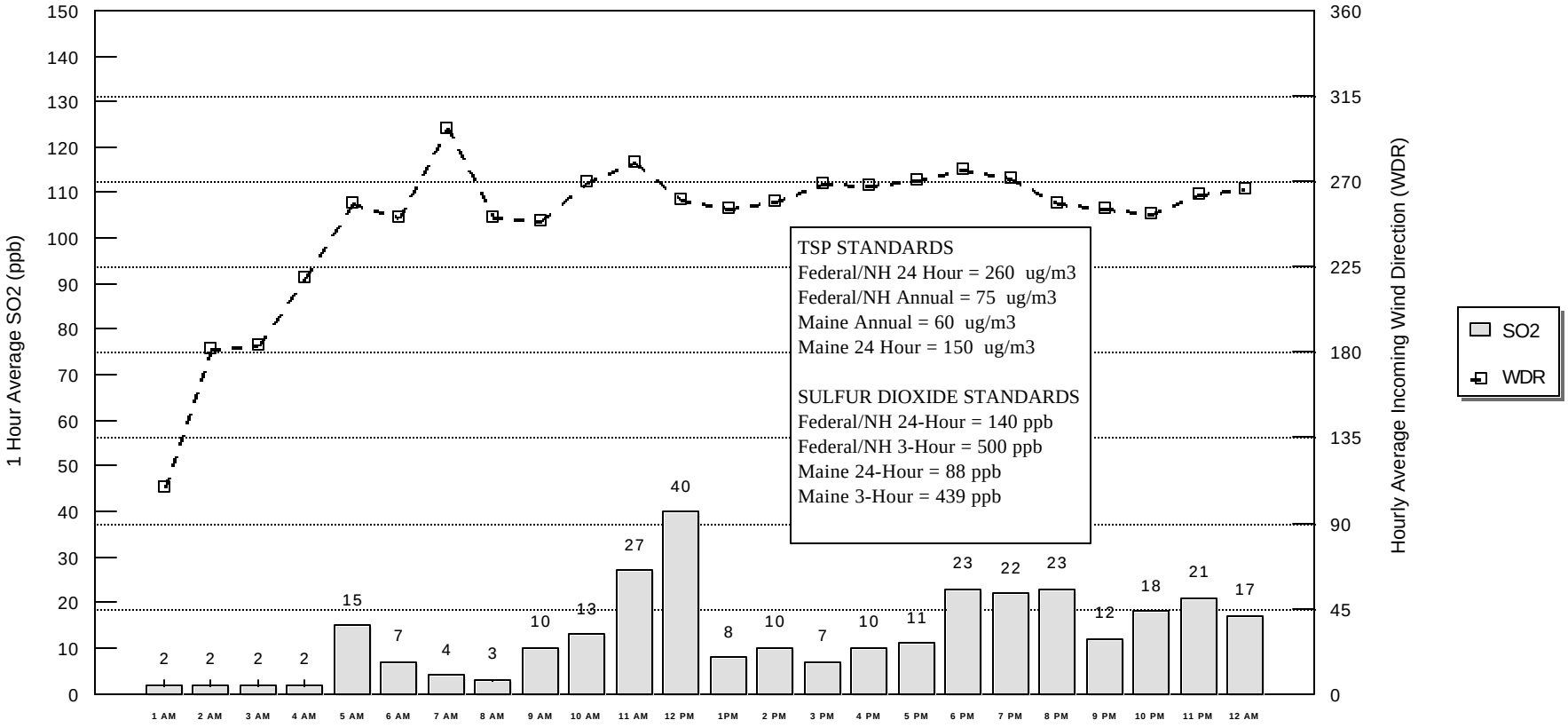
Max 3-Hour SO2 Avg. = 2 ppb 24 Hour SO2 Avg.= 2 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME

August 28, 1999 - 24-hour TSP Concentration = 44 ug/m3



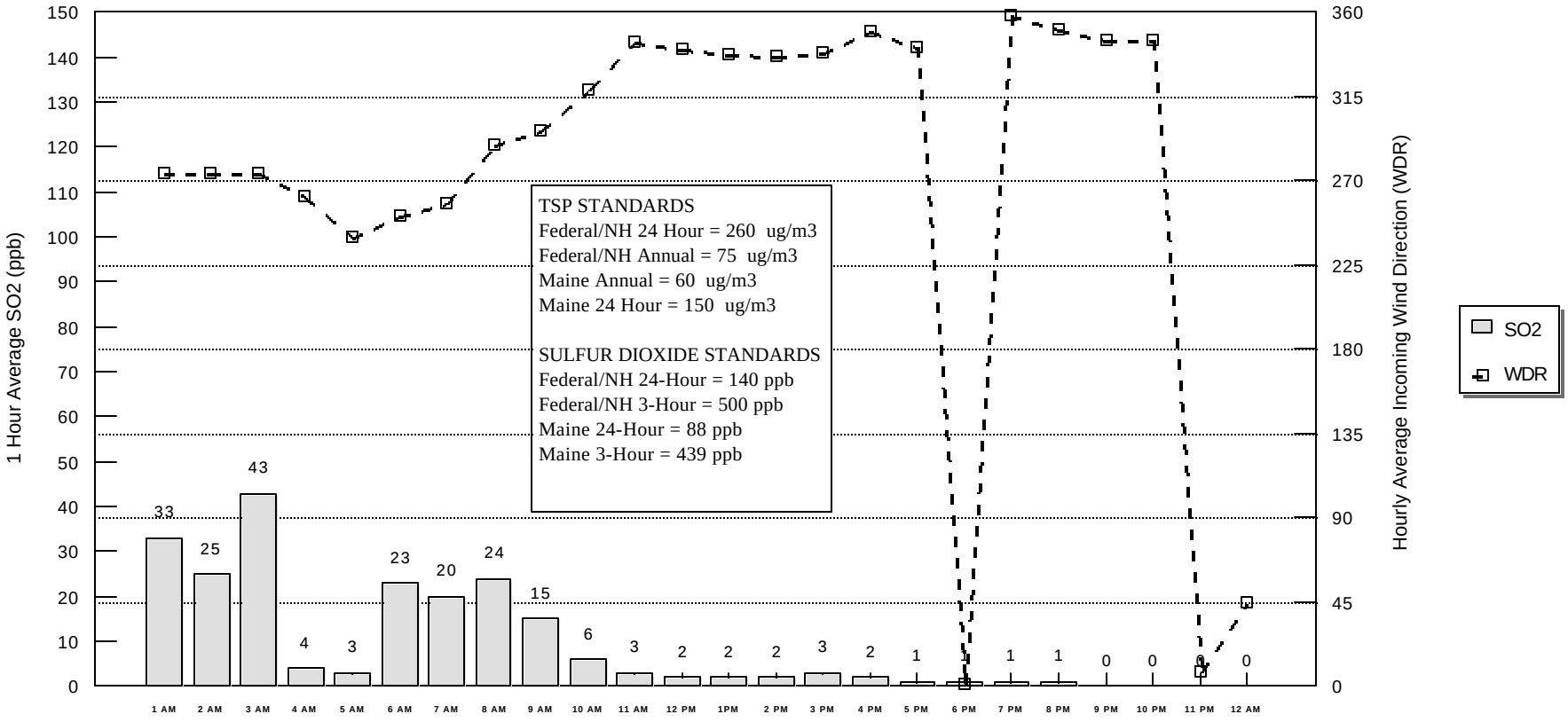
TSP STANDARDS
Federal/NH 24 Hour = 260 ug/m3
Federal/NH Annual = 75 ug/m3
Maine Annual = 60 ug/m3
Maine 24 Hour = 150 ug/m3

SULFUR DIOXIDE STANDARDS
Federal/NH 24-Hour = 140 ppb
Federal/NH 3-Hour = 500 ppb
Maine 24-Hour = 88 ppb
Maine 3-Hour = 439 ppb

Max 3-Hour SO2 Avg. = 27 ppb 24 Hour SO2 Avg.= 13 ppb
ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME
August 29, 1999 - no TSP sample collected



TSP STANDARDS
Federal/NH 24 Hour = 260 ug/m3
Federal/NH Annual = 75 ug/m3
Maine Annual = 60 ug/m3
Maine 24 Hour = 150 ug/m3

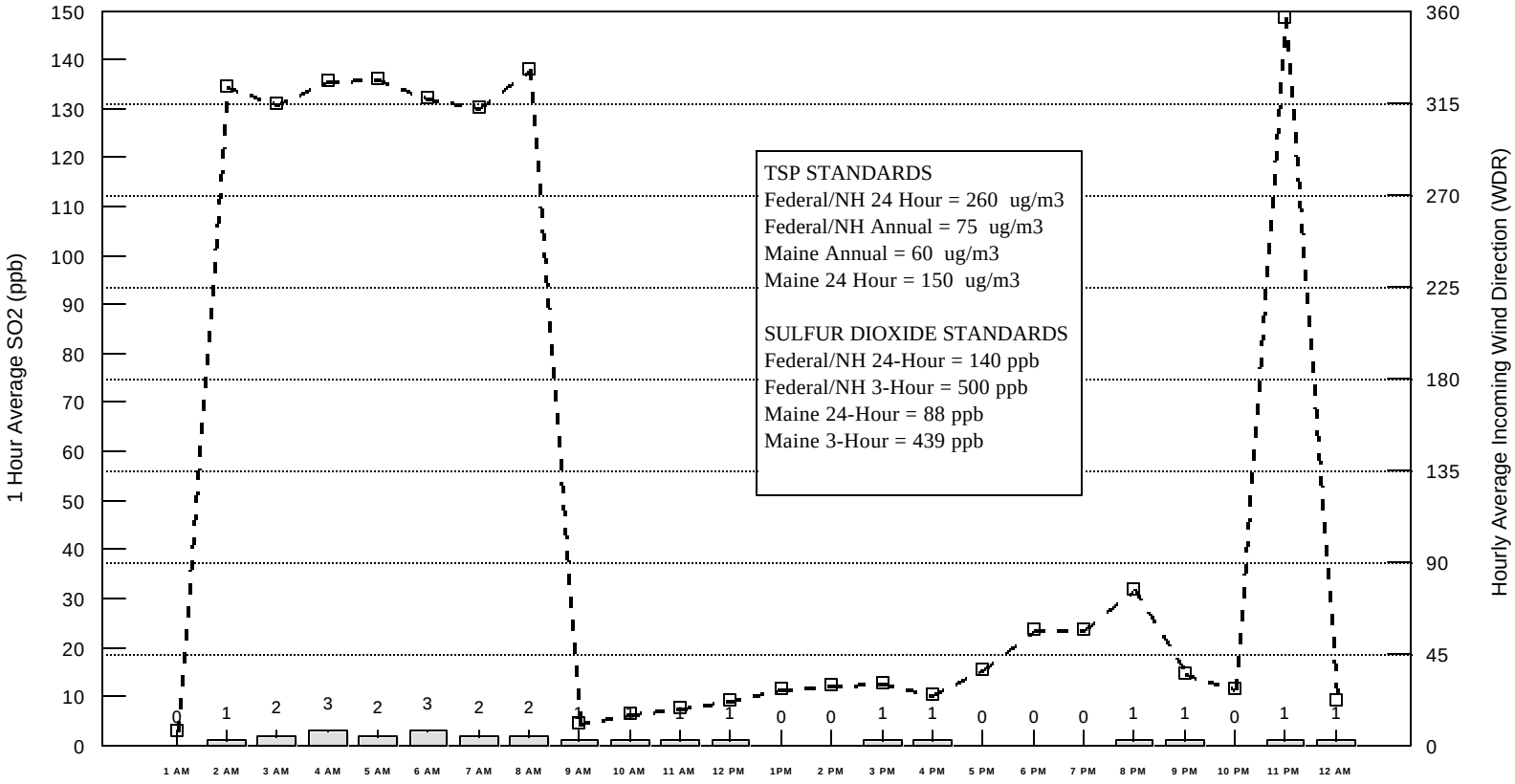
SULFUR DIOXIDE STANDARDS
Federal/NH 24-Hour = 140 ppb
Federal/NH 3-Hour = 500 ppb
Maine 24-Hour = 88 ppb
Maine 3-Hour = 439 ppb

Max 3-Hour SO2 Avg. = 34 ppb 24 Hour SO2 Avg.= 8 ppb
ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Special Ambient Air Monitoring Special Project - Eliot, ME

August 30, 1999 - 24-hour TSP Concentration = 12 ug/m3



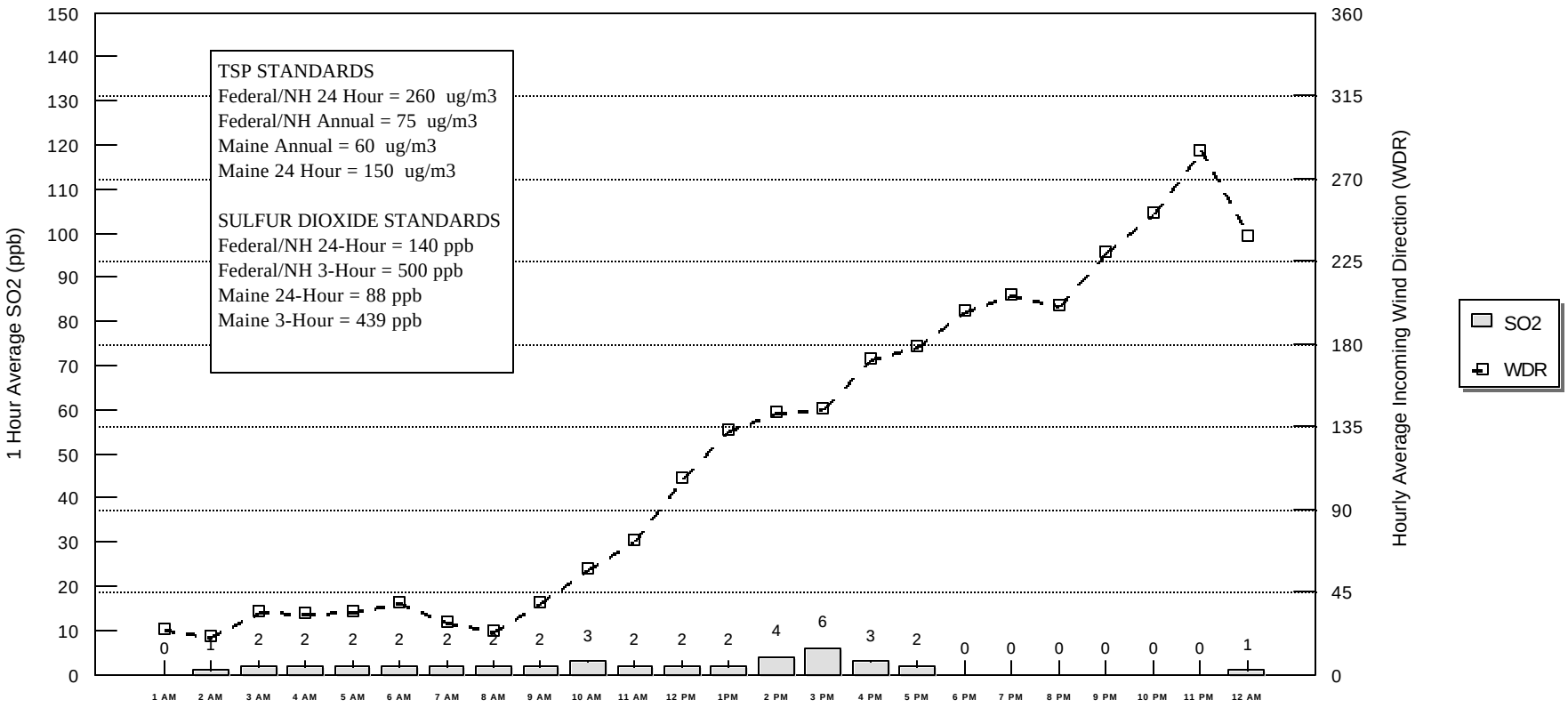
Max 3-Hour SO2 Avg. = 3 ppb 24 Hour SO2 Avg.= 1 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME

August 31, 1999 - no TSP sample collected



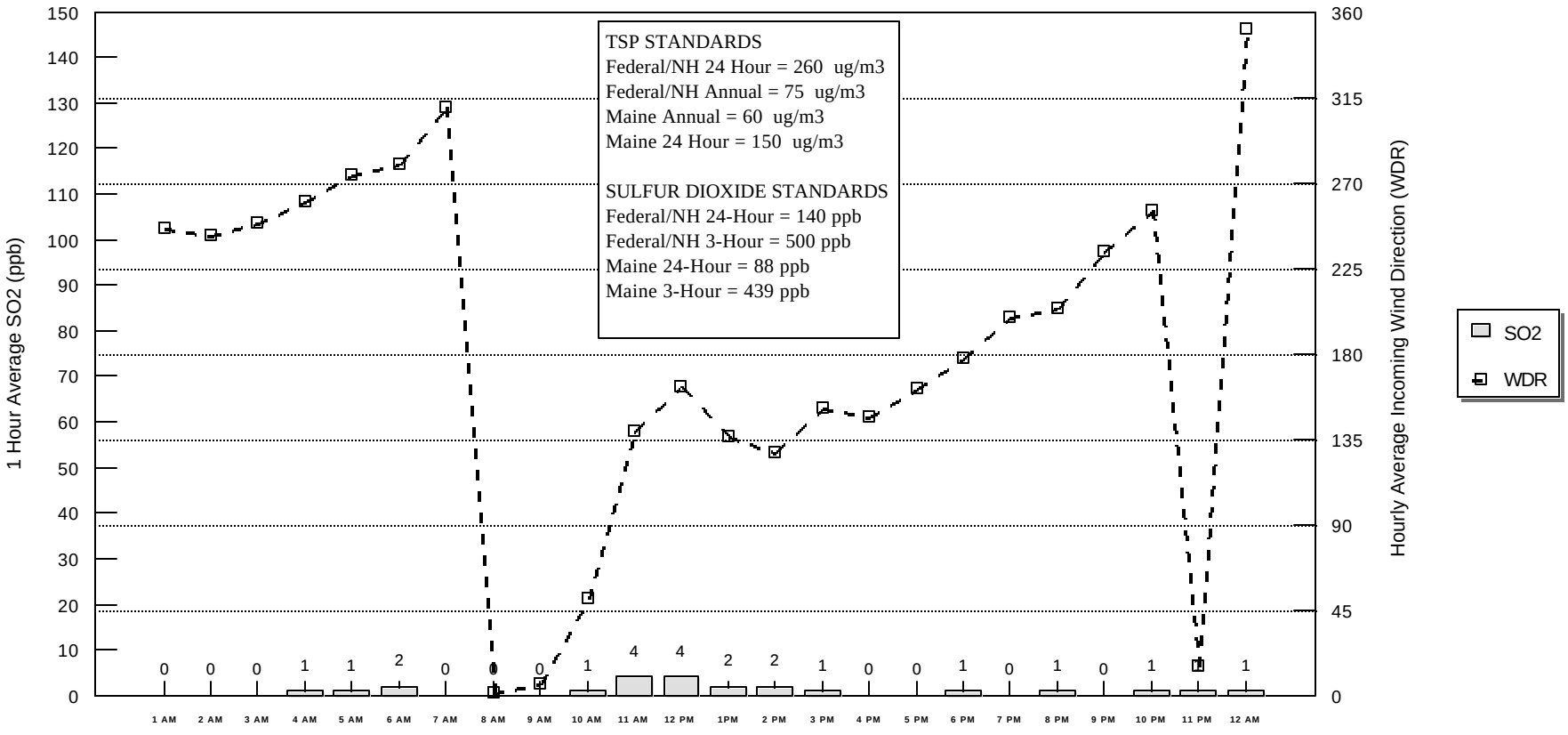
Max 3-Hour SO2 Avg. = 4 ppb 24 Hour SO2 Avg.= 2 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME

September 1, 1999 - 24-hour TSP Concentration = 13 ug/m3

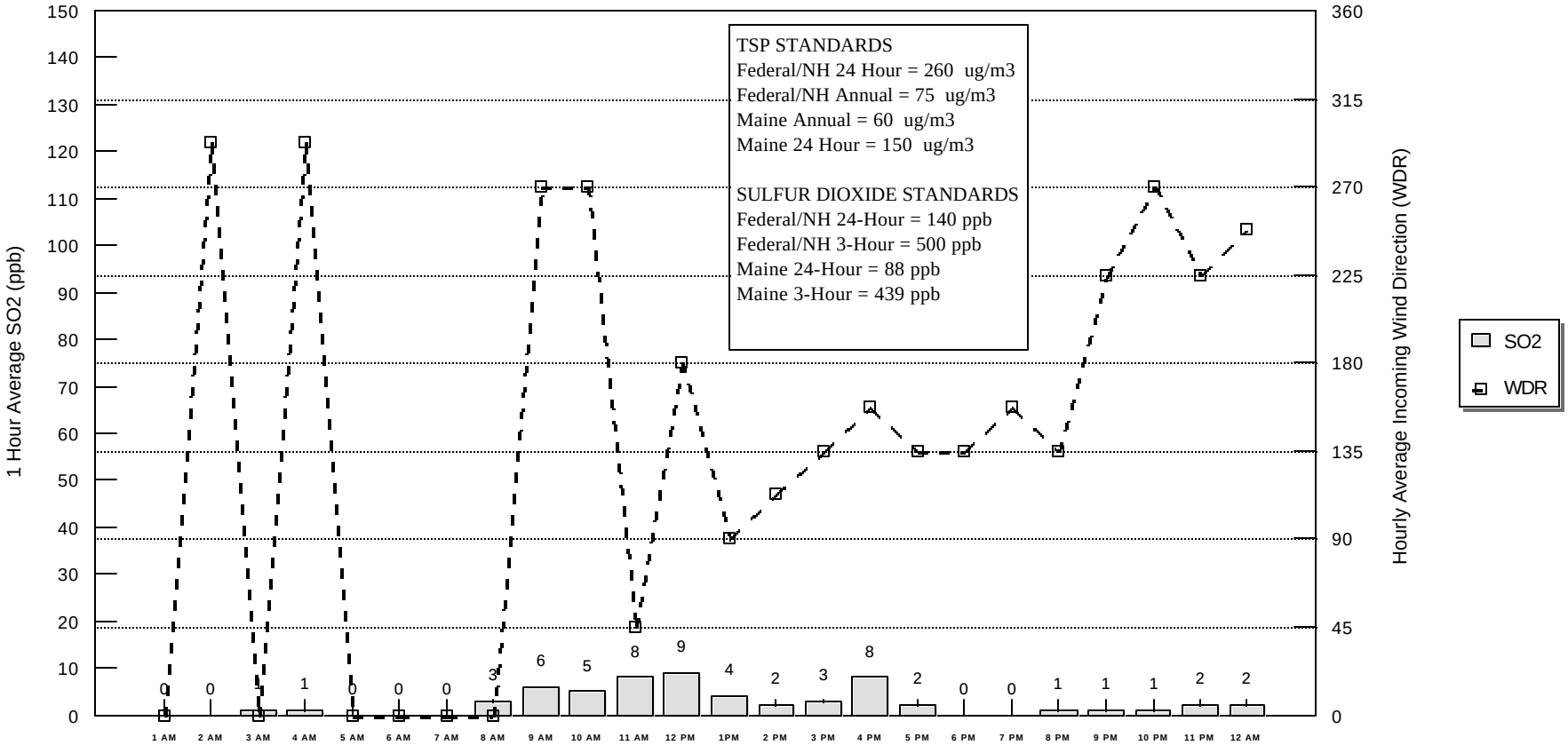


Max 3-Hour SO2 Avg. = 3 ppb 24 Hour SO2 Avg.= 1 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME
September 2, 1999 - no TSP sample collected



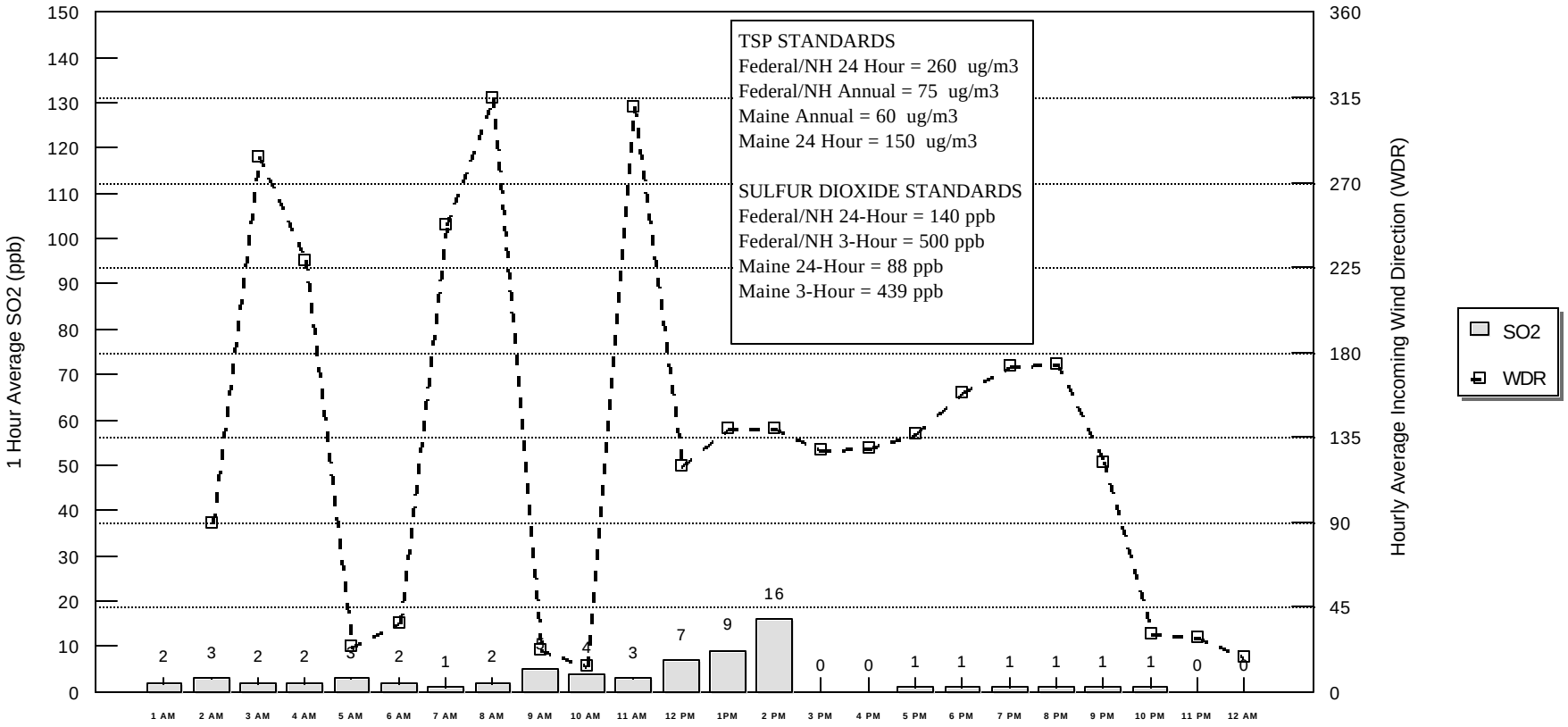
Max 3-Hour SO2 Avg. = 7 ppb 24 Hour SO2 Avg.= 2 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME

September 3, 1999 - 24-hour TSP Concentration = 18 ug/m3

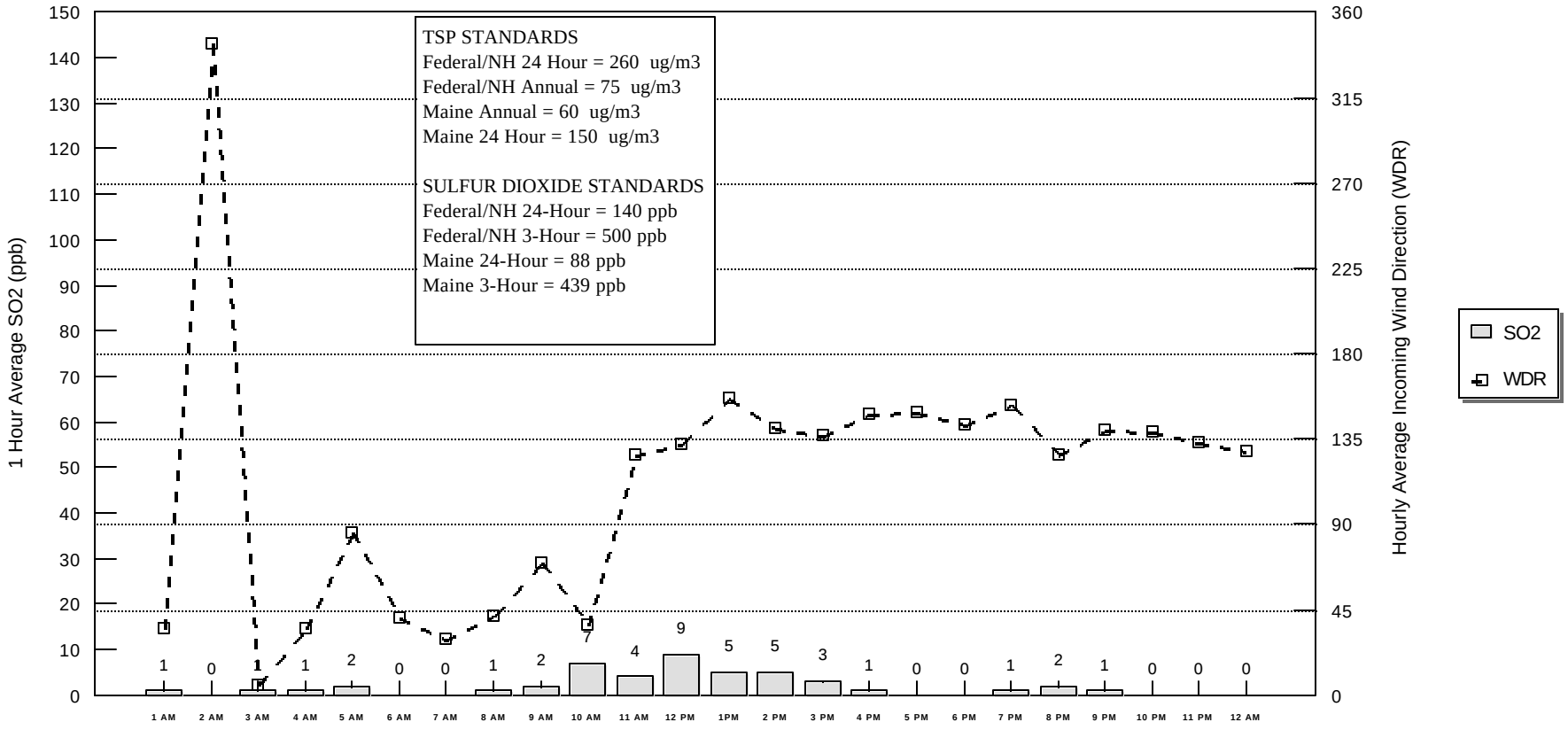


Max 3-Hour SO2 Avg. = 11 ppb 24 Hour SO2 Avg.= 3 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME
September 4, 1999 - no TSP sample collected



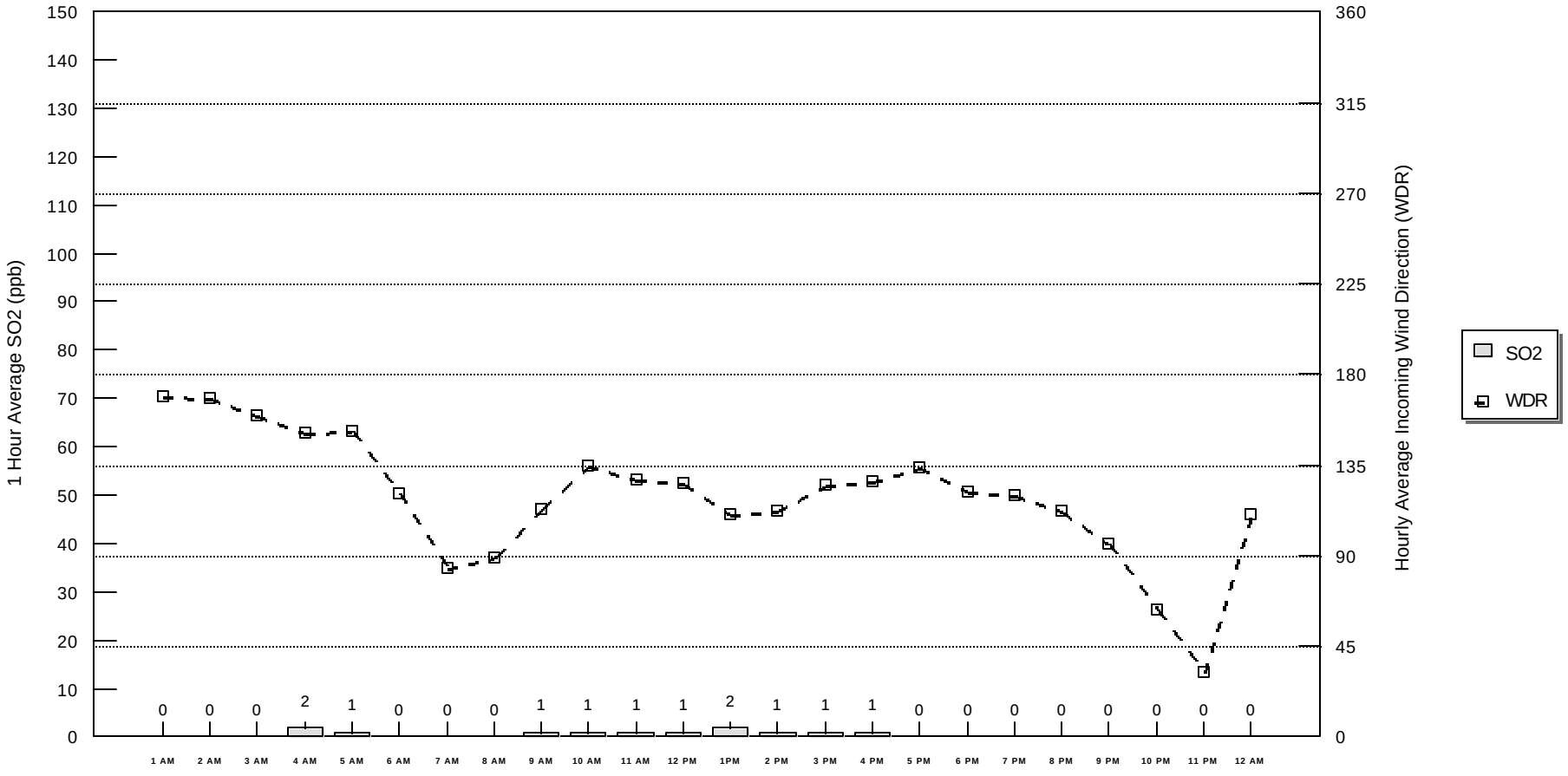
Max 3-Hour SO2 Avg. = 7 ppb 24 Hour SO2 Avg.= 2 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME

September 5, 1999 - 24-hour TSP Concentration = 9 ug/m3

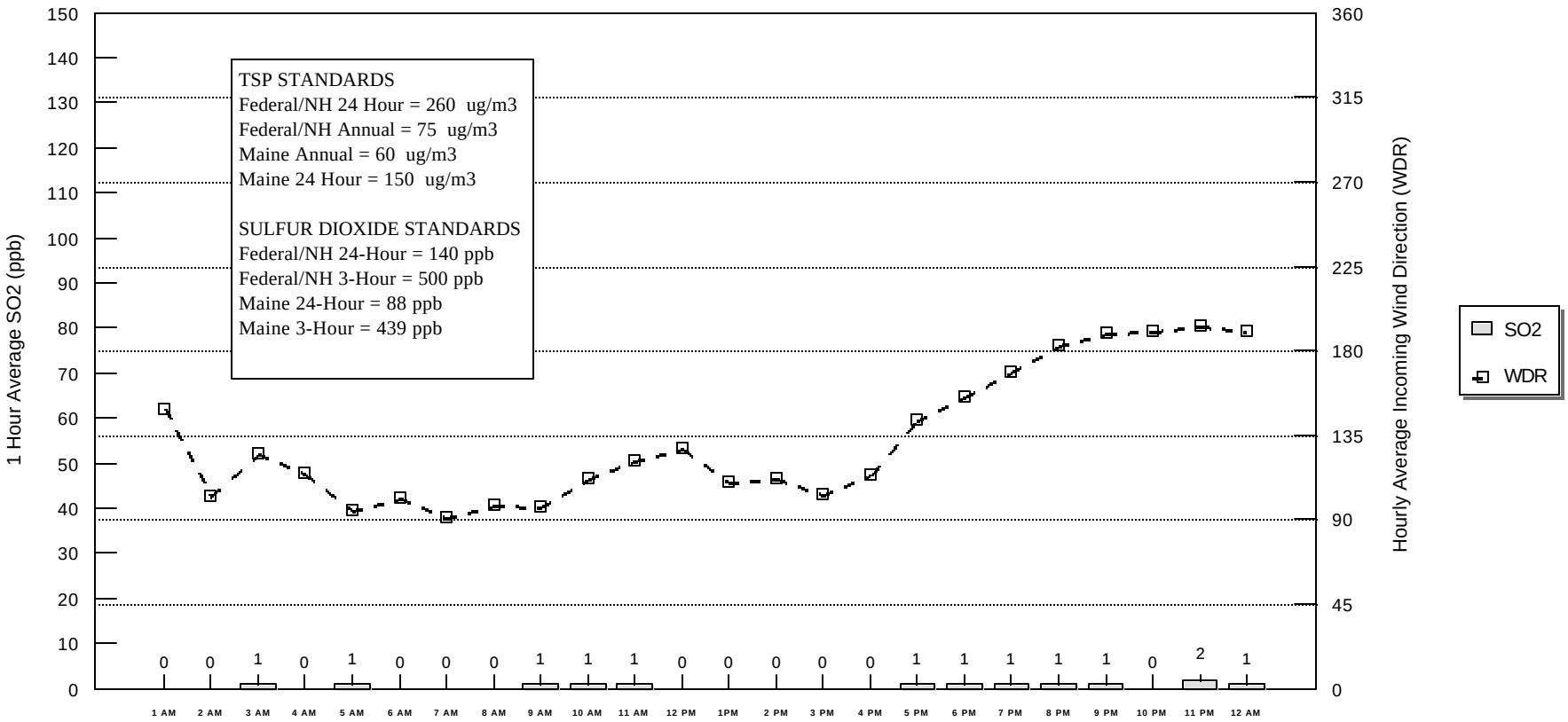


Max 3-Hour SO2 Avg. = 1 ppb 24 Hour SO2 Avg.= 1 ppb

ug/m3 = micrograms per cubic meter

Ambient Air Monitoring Special Project - Eliot, ME

September 6, 1999 - no TSP sample collected



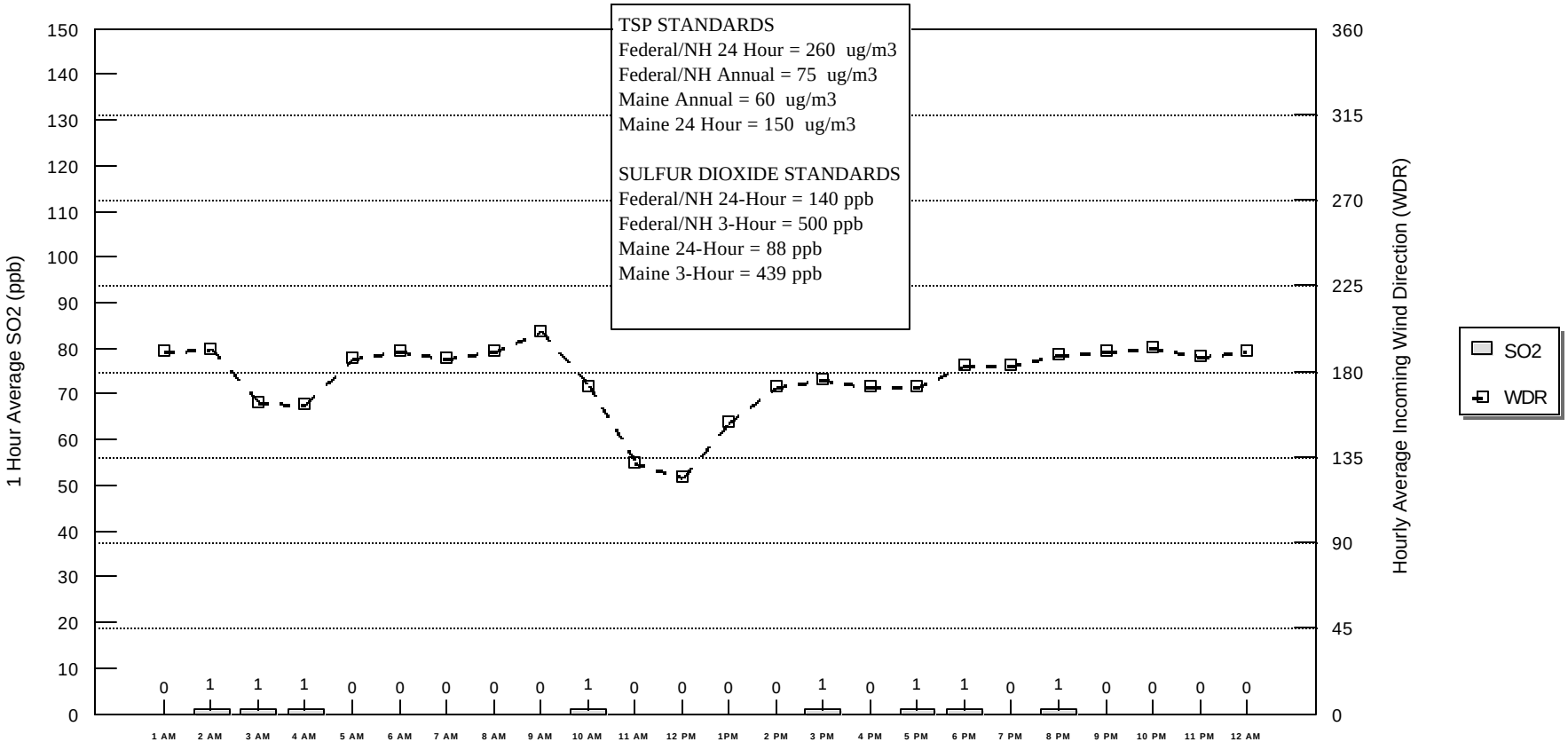
Max 3-Hour SO2 Avg. = 1 ppb 24 Hour SO2 Avg.= 1 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME

September 7, 1999 - 24-hour TSP Concentration = 17 ug/m3

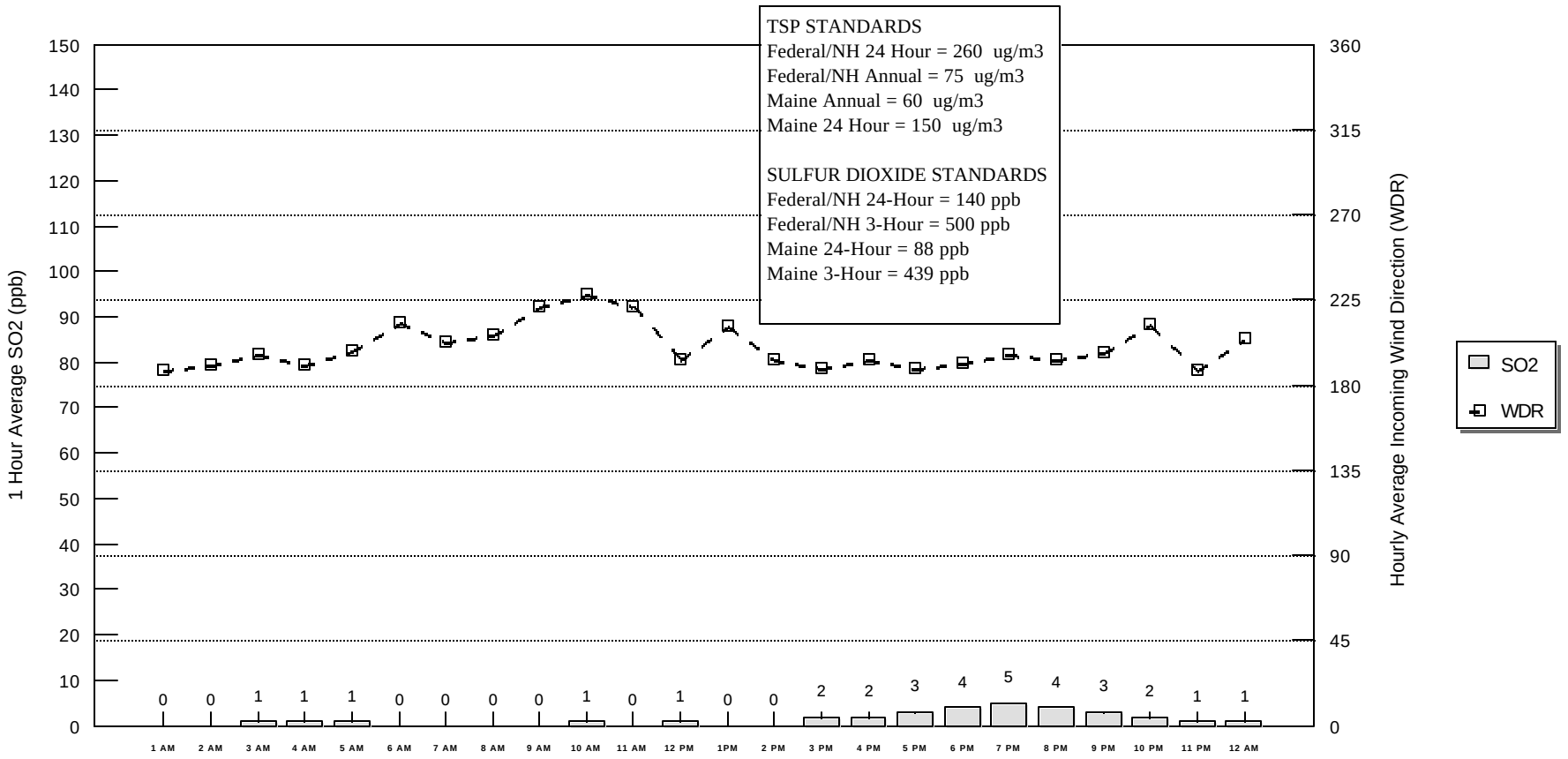


Max 3-Hour SO2 Avg. = 1 ppb 24 Hour SO2 Avg.= 0 ppb
ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME

September 8, 1999 - no TSP sample collected



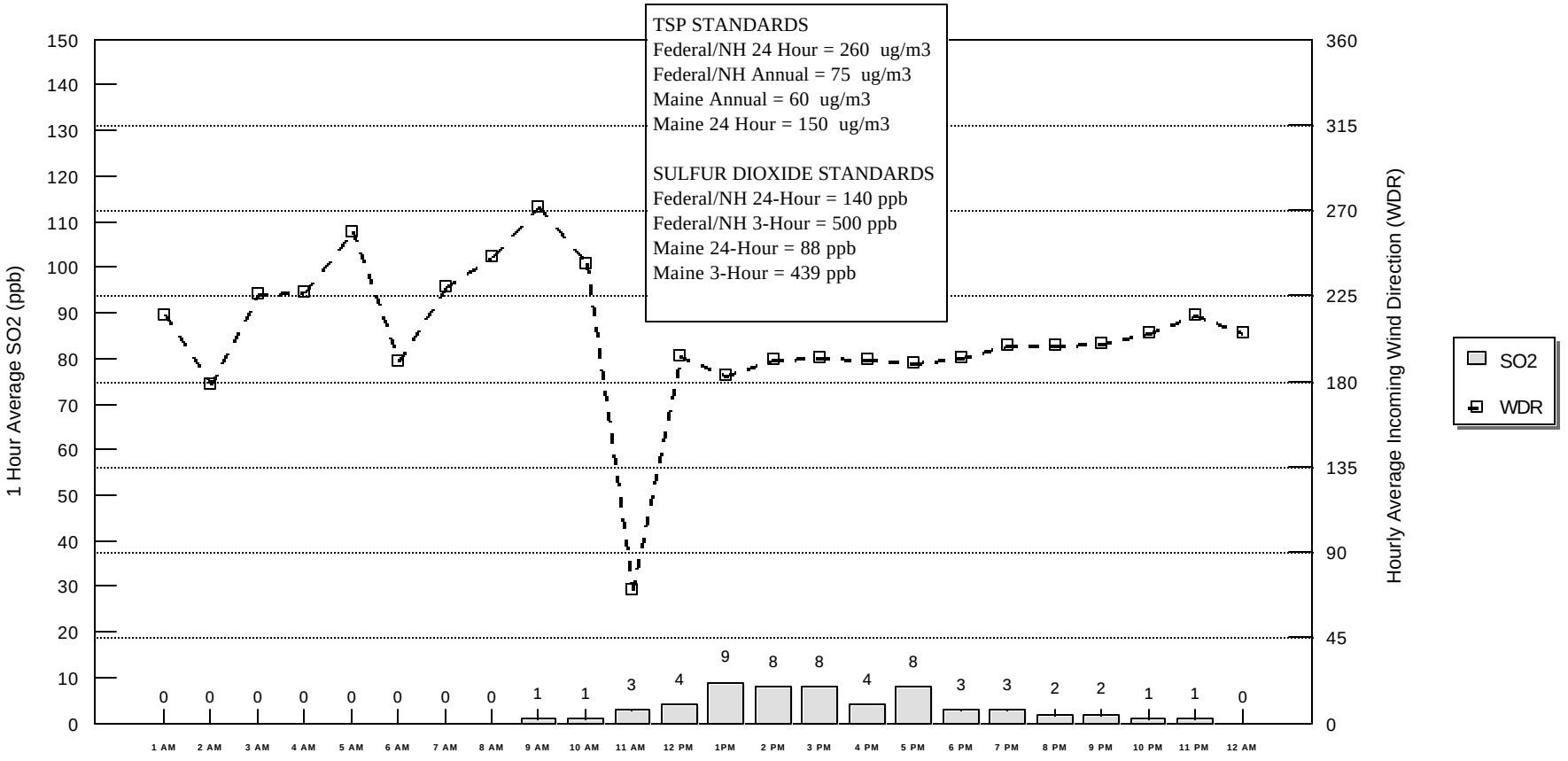
Max 3-Hour SO2 Avg. = 4 ppb 24 Hour SO2 Avg.= 1 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME

September 9, 1999 - 24-hour TSP Concentration = 28 ug/m3



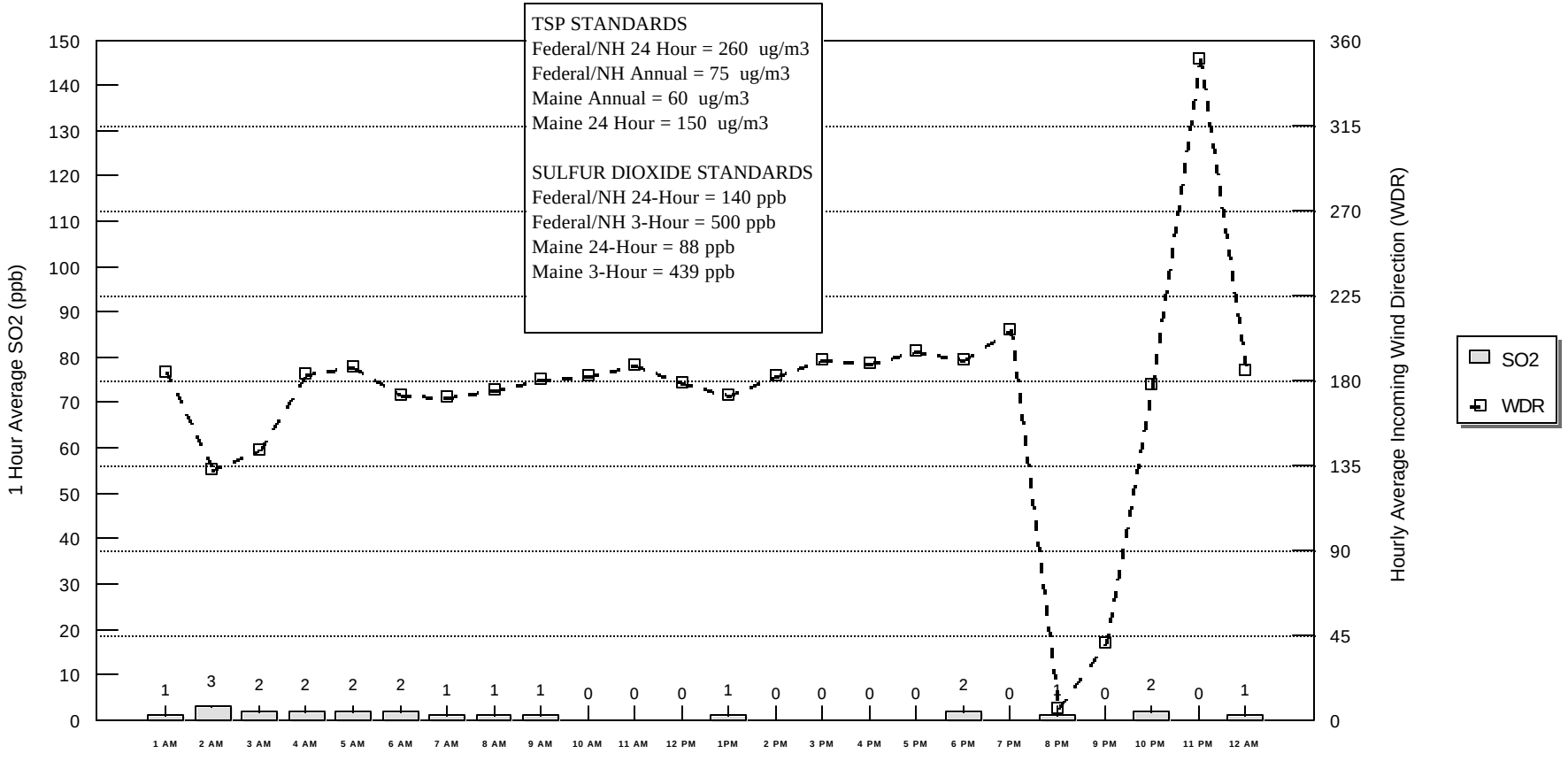
Max 3-Hour SO2 Avg. = 8 ppb 24 Hour SO2 Avg.= 2 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME

September 10, 1999 - no TSP sample collected



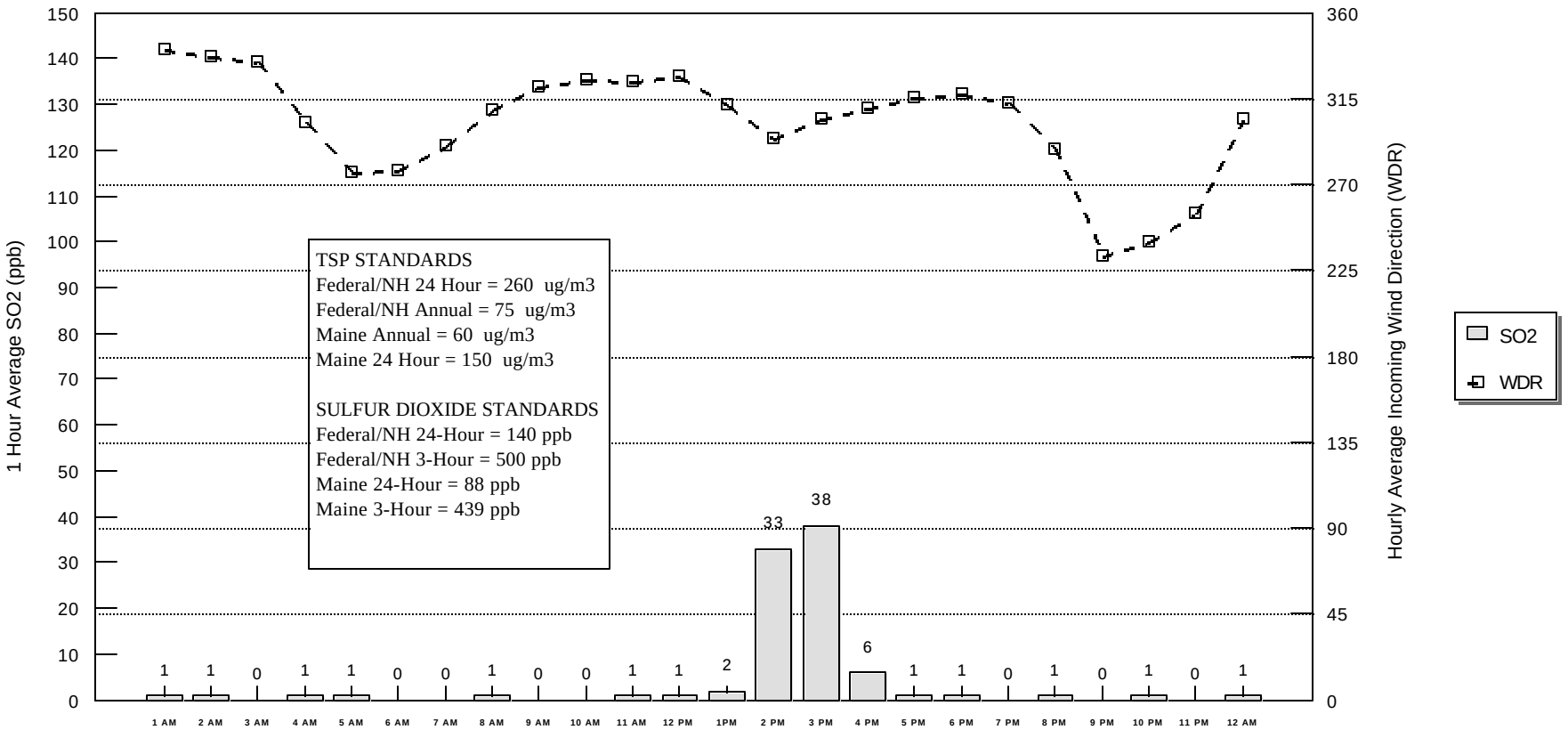
Max 3-Hour SO2 Avg. = 2 ppb 24 Hour SO2 Avg.= 1 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME

September 11, 1999 - 24-hour TSP Concentration = 13 ug/m3



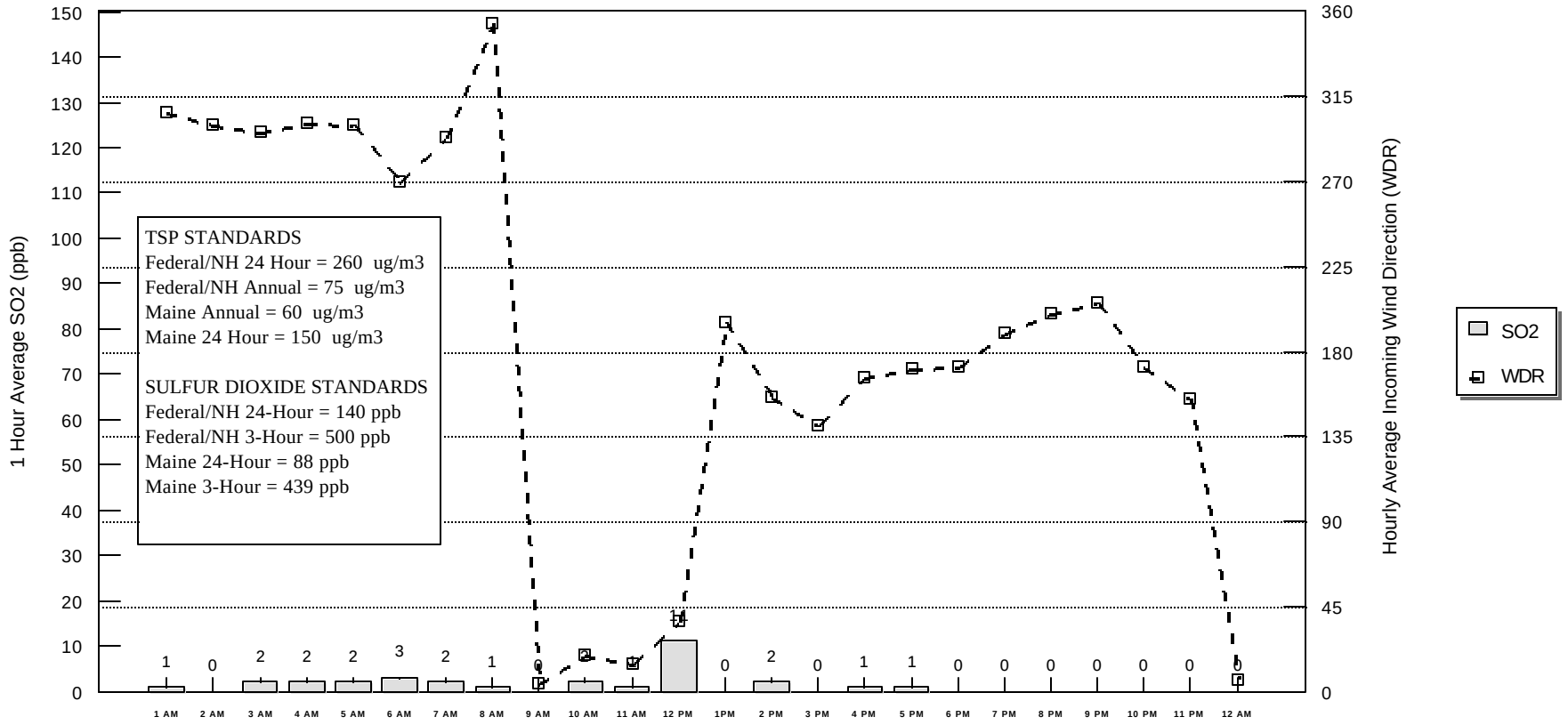
Max 3-Hour SO2 Avg. = 26 ppb 24 Hour SO2 Avg.= 4 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME

September 12, 1999 - no TSP sample collected



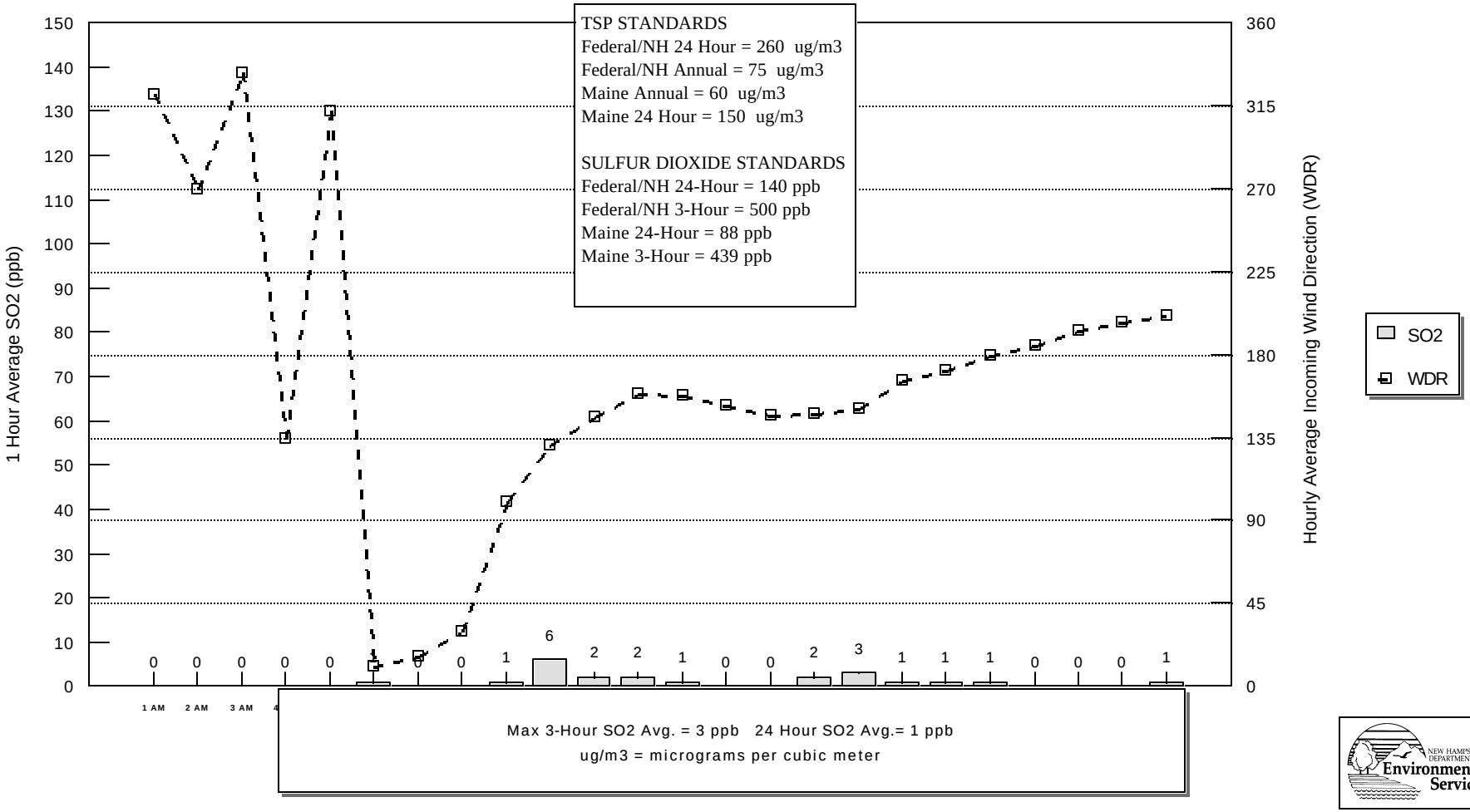
Max 3-Hour SO2 Avg. = 5 ppb 24 Hour SO2 Avg.= 1 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

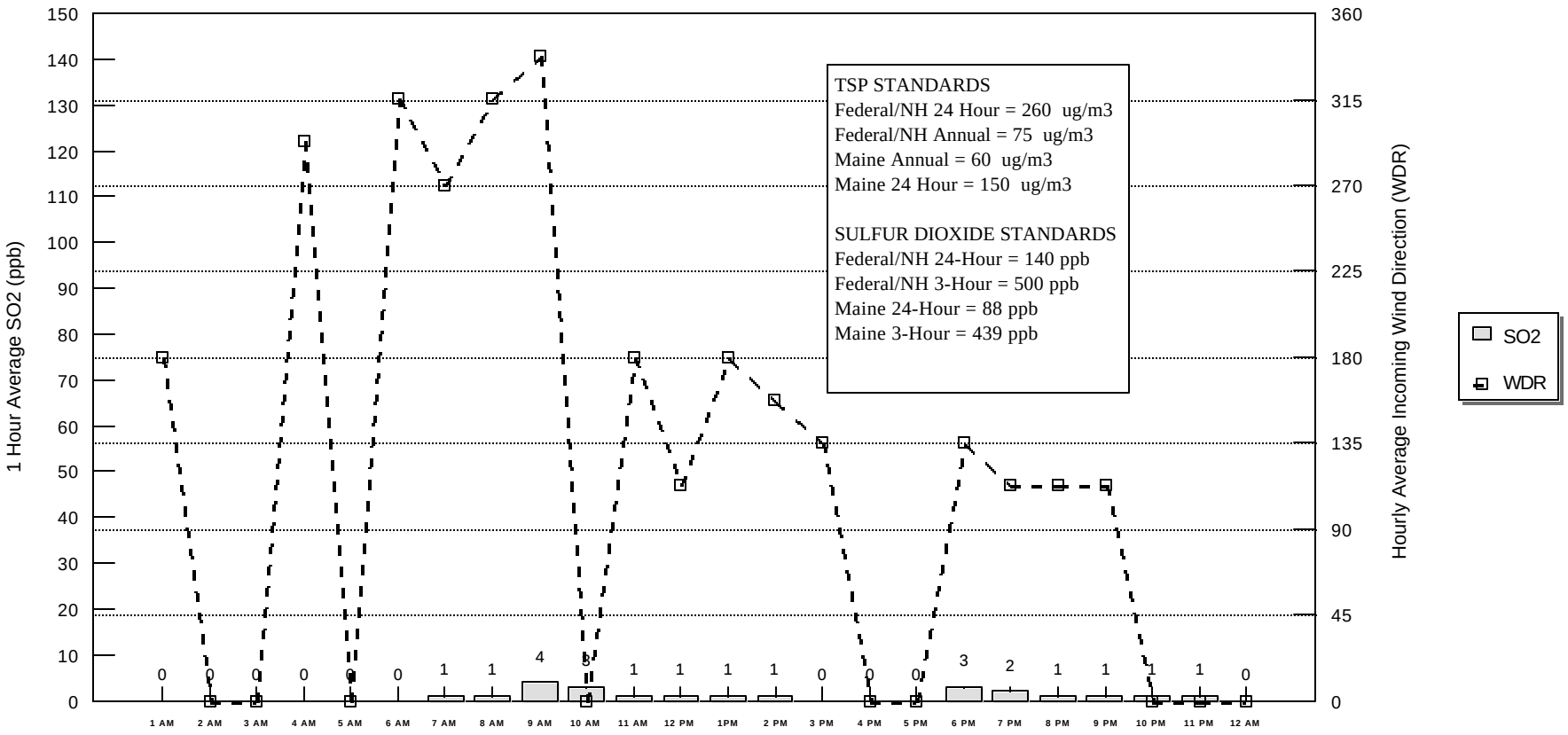
Ambient Air Monitoring Special Project - Eliot, ME

September 13, 1999 - 24-hour TSP Concentration = 23 ug/m3



Ambient Air Monitoring Special Project - Eliot, ME

September 14, 1999 - no TSP sample collected



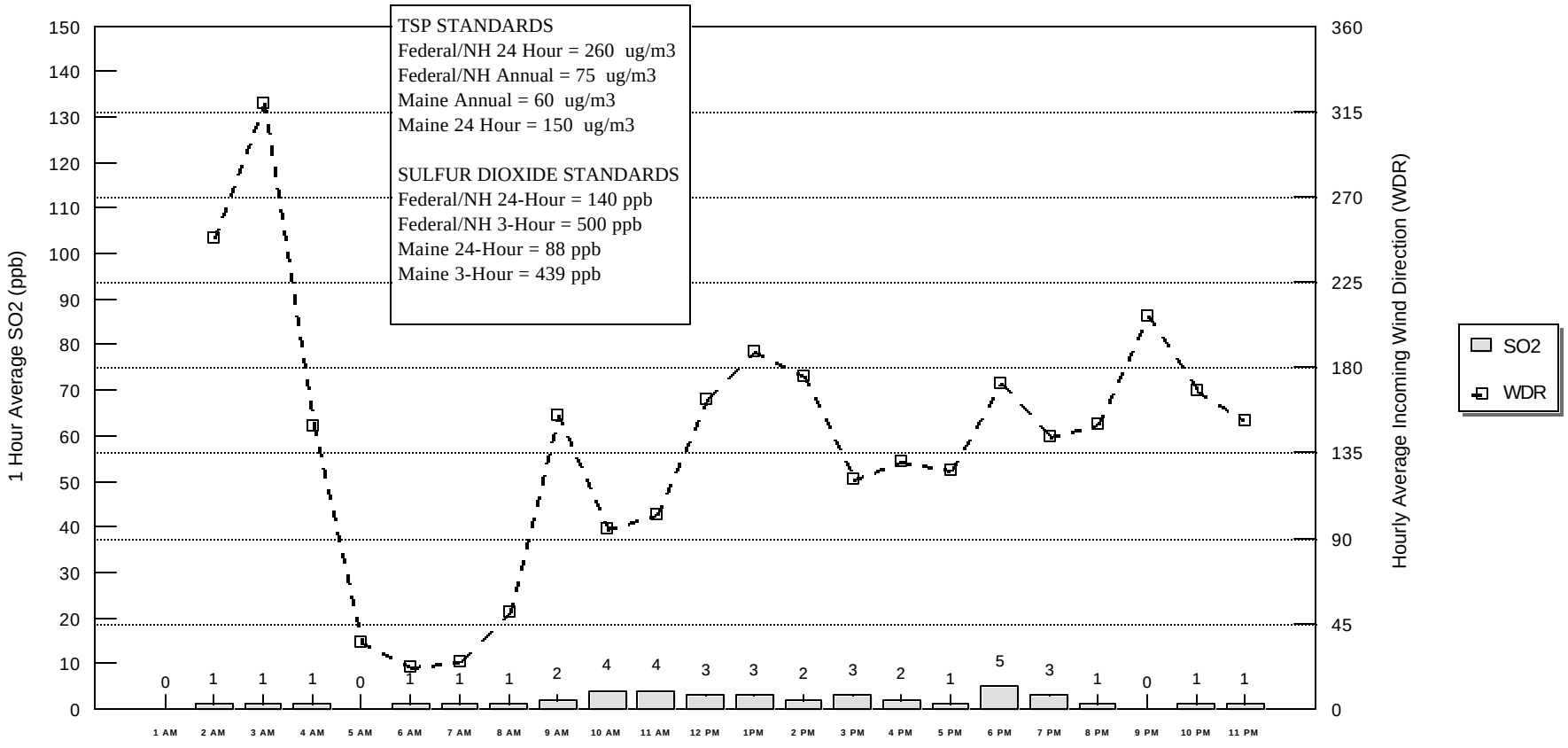
Max 3-Hour SO2 Avg. = 3 ppb 24 Hour SO2 Avg.= 1 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME

September 15, 1999 - 24-hour TSP Concentration = 23 ug/m3



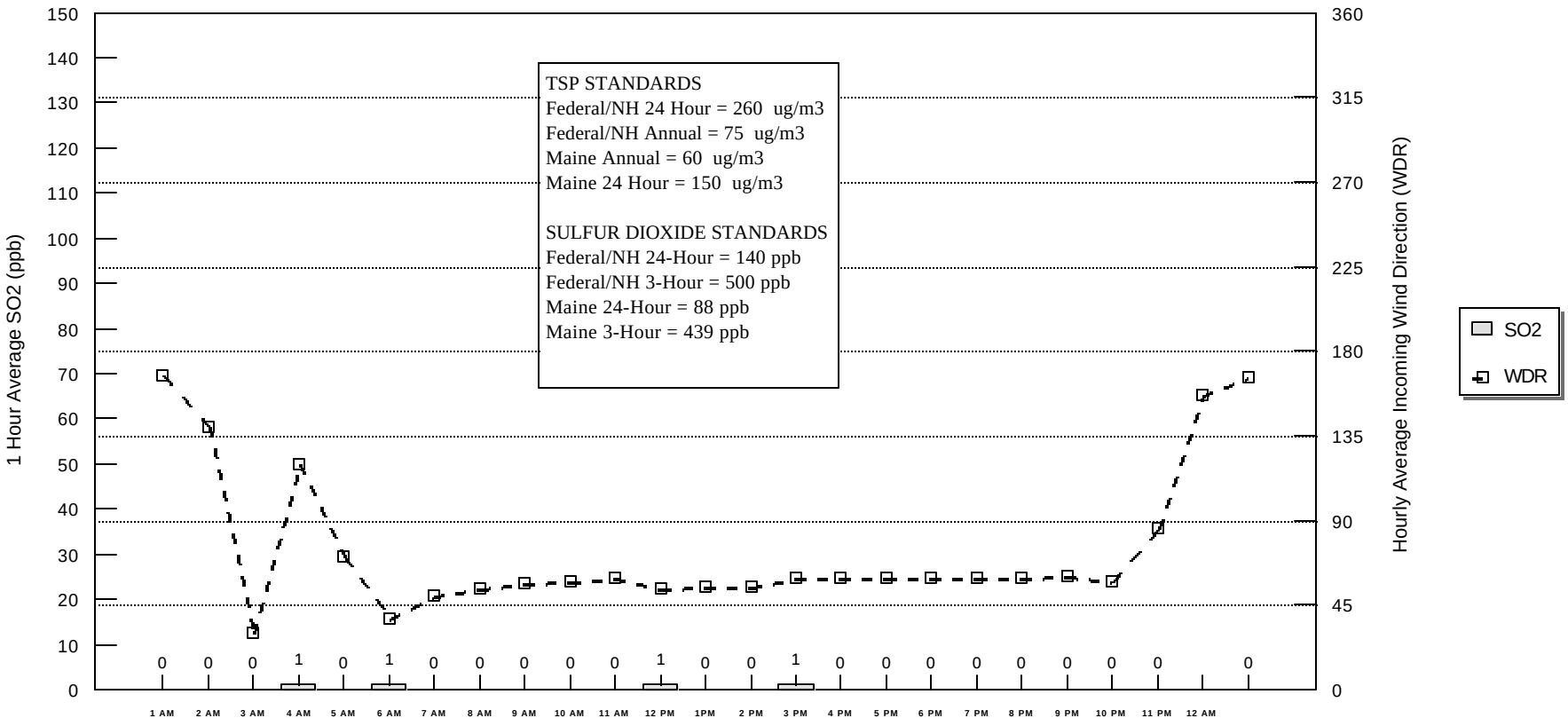
Max 3-Hour SO2 Avg. = 4 ppb 24 Hour SO2 Avg.= 2 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME

September 16, 1999 - no TSP sample collected



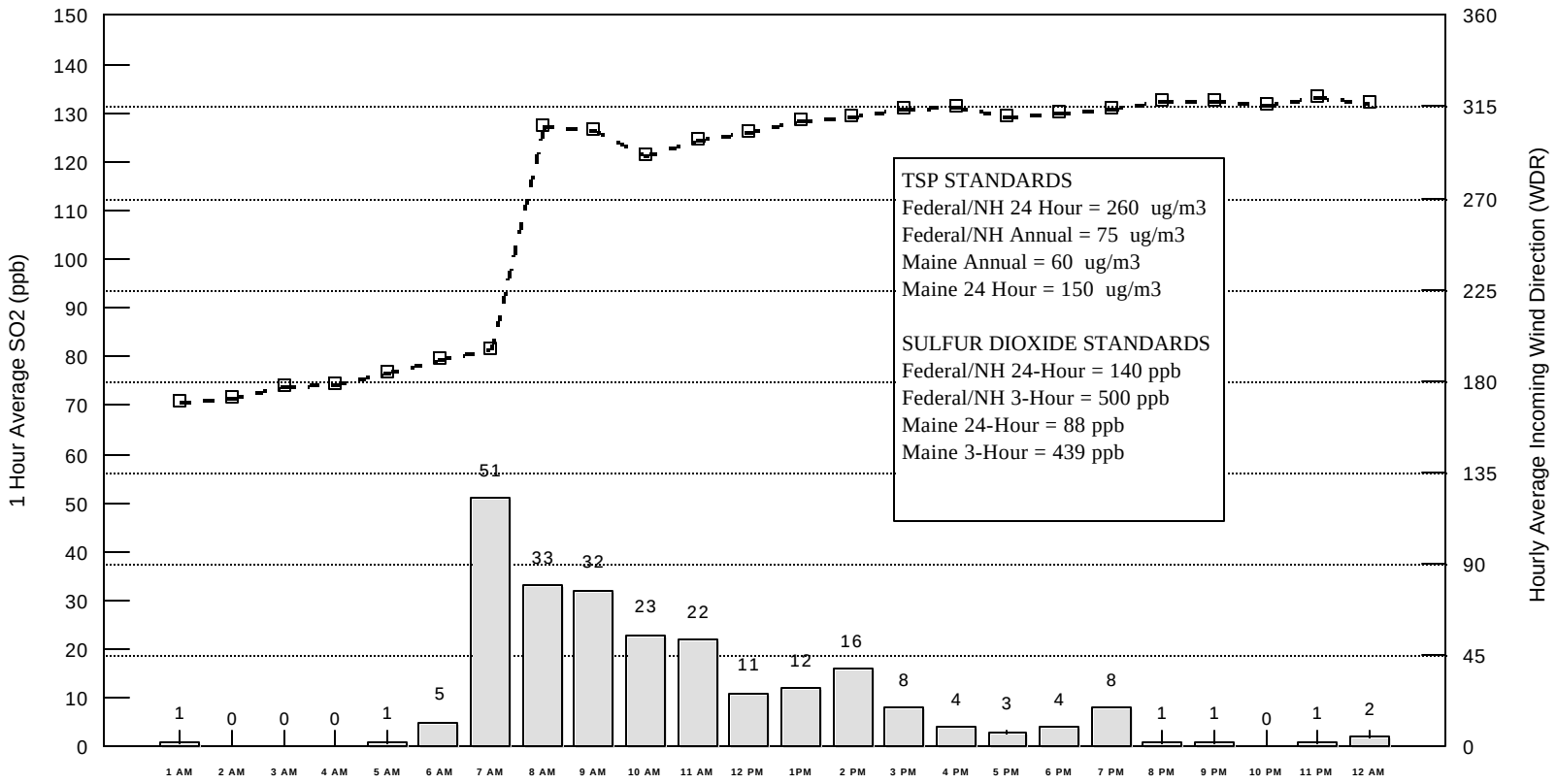
Max 3-Hour SO2 Avg. = 1 ppb 24 Hour SO2 Avg.= 0 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME

September 17, 1999 - no TSP sample collected



TSP STANDARDS
Federal/NH 24 Hour = 260 ug/m3
Federal/NH Annual = 75 ug/m3
Maine Annual = 60 ug/m3
Maine 24 Hour = 150 ug/m3

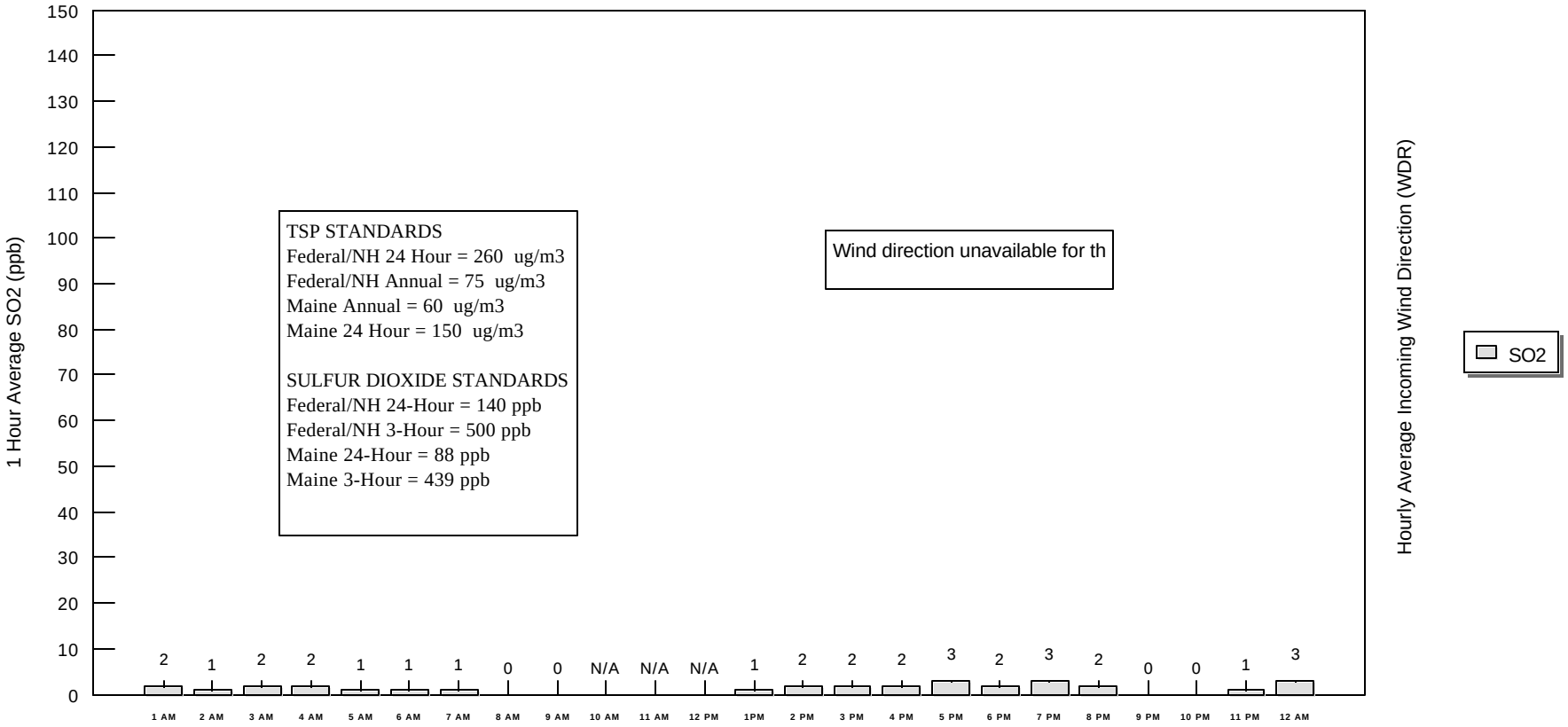
SULFUR DIOXIDE STANDARDS
Federal/NH 24-Hour = 140 ppb
Federal/NH 3-Hour = 500 ppb
Maine 24-Hour = 88 ppb
Maine 3-Hour = 439 ppb

Max 3-Hour SO2 Avg. = 39 ppb 24 Hour SO2 Avg.= 10 ppb
ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME

September 18, 1999 - 24-hour TSP Concentration = 13 ug/m3



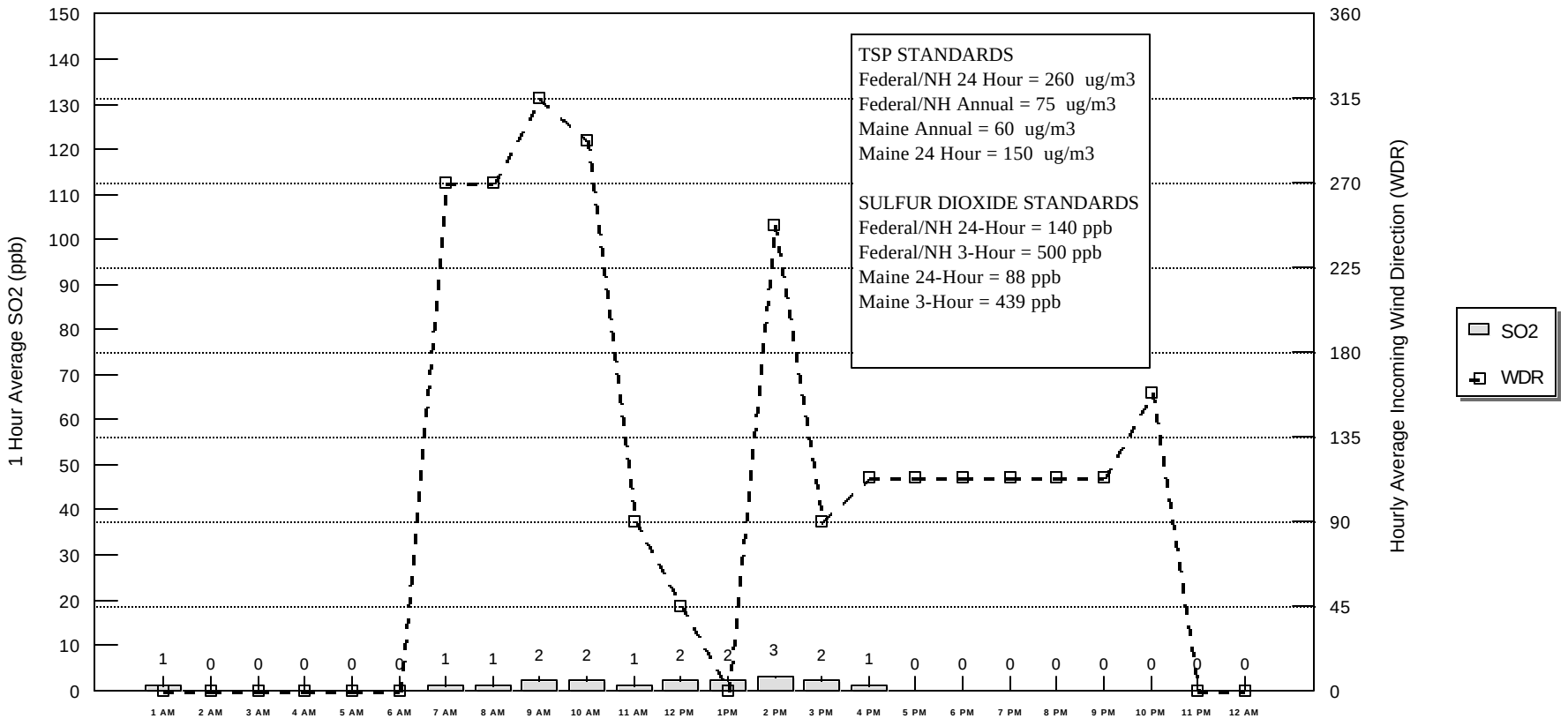
Max 3-Hour SO2 Avg. = 3 ppb 24 Hour SO2 Avg.= 1 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME

September 19, 1999 - 24-hour TSP Concentration = 12 ug/m3



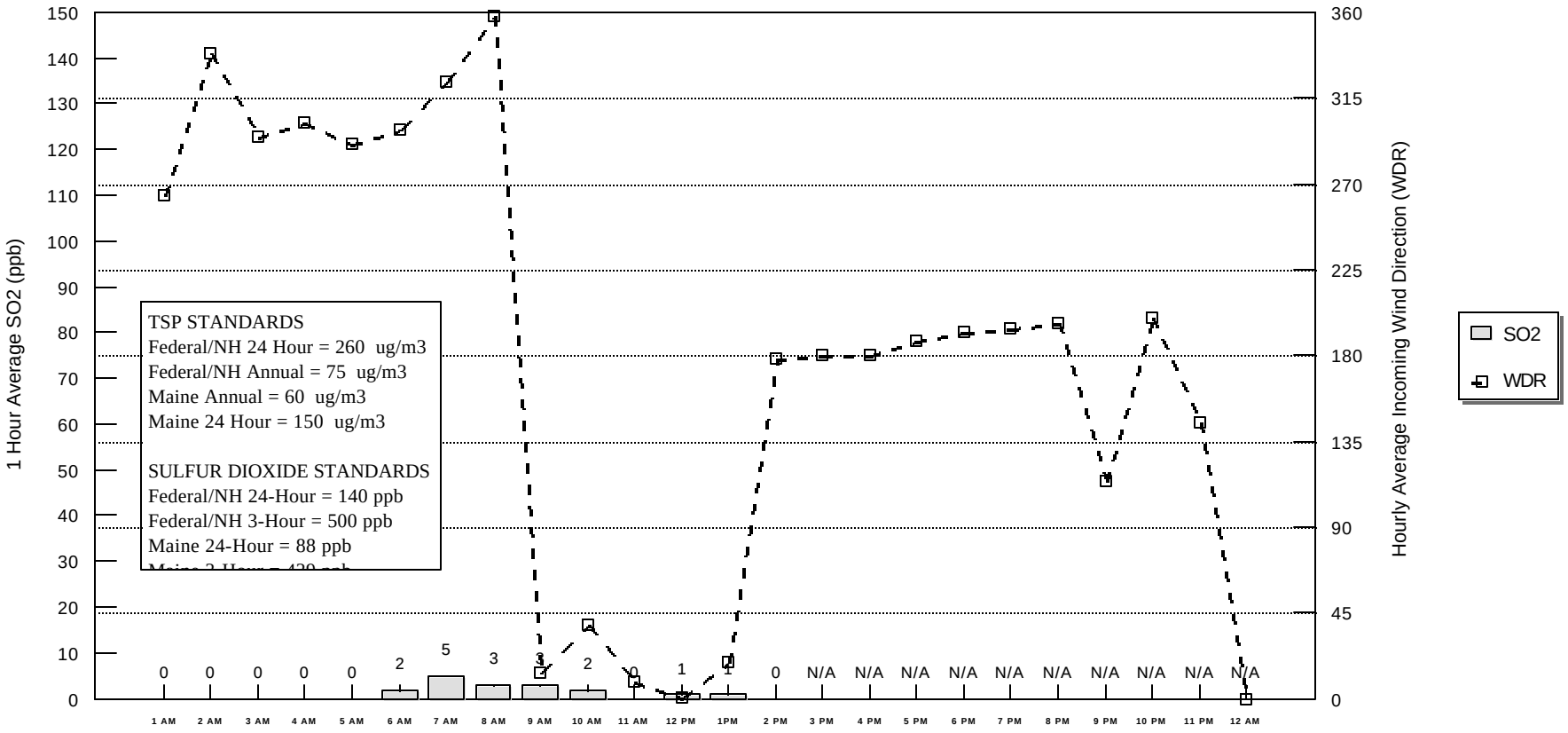
Max 3-Hour SO2 Avg. = 2 ppb 24 Hour SO2 Avg.= 1 ppb

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Ambient Air Monitoring Special Project - Eliot, ME

September 20, 1999 - no TSP sample collected



Max 3-Hour SO2 Avg. = 4 ppb 24 Hour SO2 Avg.= N/A

ug/m3 = micrograms per cubic meter

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

APPENDIX B

Microscopy Analysis

Report of
Severn Trent Laboratories, Billerica, MA

Committed To *Your* Success

Severn Trent Laboratories
149 Rangeway Road
N.Billerica, MA 01862

Tel: (978) 667-1400
Fax: (978) 667-7871
www.stl-inc.com

NH Department of Environmental Services
6 Hazen Drive, PO Box 95
Concord, NH 03302-0095

Attention: Paul Sandbourn
STL Job #: 28155
Billing Ref.:

November 22, 1999

Dear Paul:

Please find enclosed five (5) PLM color photomicrographs, nine (9) SEM photomicrographs and nine (9) EDX spectra of the four samples, and blank, which you submitted for examination and identification of the dust composition. Also enclosed are the results of the two (2) High Volume (HiVol) air filters which you also submitted for Total Suspended Particulate (TSP) analysis.

METHODS:

For the TSP analysis, particles on the HiVol samples were transferred onto microscope slides, immersed in oil of calibrated index of refraction (n=1.605), examined and photographed under transmitted polarized light microscopy. 100 individual particles per sample were sized and identified as one of the categories you requested (minerals, ambiguous soots, oil soot, vehicle soot, coal dust, coal ash, and biologicals). Photomicrographs were taken at approximately 500X.

Each of the four samples, plus the blank, were mounted in index oil (n=1.605) on glass slides for an initial PLM examination. Another portion of each sample was mounted on double-sided tape and coated with evaporated graphite for the SEM analysis. Photos were taken of each dust sample both by PLM and by SEM. Percentages of the material composing the dust sample were made by visual estimate under the PLM. The percentages and identification of materials was confirmed by the SEM examination. Energy Dispersive X-Ray (EDX) spectra were plotted out for the coal dust, oil soot and coal ash photographed. EDX spectra were taken, but not plotted out, for five to ten other coal dust and oil soot particles in each sample.

FINDINGS:

Please refer to the SEM photomicrographs, PLM color photomicrographs, the EDX spectra and the TSP reports. The following are the results of the PLM visual estimates.

082999-1:	80%	Opaques (coal dust, oil soot, coal ash)
(Heavy loading)	15%	Mineral grains
	5%	Biologicals (spores, pollen)

082999-2:	95%	Opaques (coal dust, oil soot, coal ash)
(Light loading)	4%	Mineral grains
	1%	Biologicals (spores, pollen)
083199-2:	90%	Opaques (coal dust, oil soot, coal ash)
(Heavy loading)	7%	Mineral grains
	3%	Biologicals (spores, wood chips, vegetable matter, pollen)
090699-1:	80%	Opaques (coal dust, coal ash, rubber dust)
(Very light loading)	10%	Mineral grains
	10%	Biologicals (spores, pollen)

Samples 082999-1 and 083199-2 contained the heaviest particle loading. Samples 082999-2 and 090699-1 contained a light to very light particle loading. The PLM results for these samples show a very similar composition in each of these samples. Coal dust is the major component in all of these samples. Mineral matter typically found in soil was detected in each of these samples between 5 and 15%. Oil soot was detected in all the samples except for sample 090699-1. Coal ash was detected in low concentrations, 5% or less, was detected in each sample. Biologicals, mainly spores and pollen, were detected in all of these samples. The blank sample contained only cotton and synthetic fibers from the wipe. These fibers were considered background from the wipe when detected in the other samples. The black arrows on the PLM color photomicrographs label some of the oil soot, coal dust and coal ash particles seen. Oil soot appears opaque and round under the PLM. Coal dust generally forms chips with angled straight edges and coal ash is pitted and lacy in appearance.

The SEM/EDX analysis shows that the oil soot detected in these samples come from the combustion of a high sulfur, low vanadium containing fuel source. This is typical of industrial grade fuel oil. Home heating oil contains low sulfur and no vanadium. The particles of coal dust detected in these samples have fairly consistent EDX spectra. All the coal detected contain a moderate concentration of sulfur, low concentration of aluminum, and low to trace concentration of iron. Often coal contains mineral matter with a lot of iron, which shows up as a strong iron concentration in the EDX spectrum. Silicon, which is from the mineral content in the coal as well, was generally detected a low to moderate concentrations in the coal. In sample 083199-2 the coal spectrum plotted out shows a higher concentration of silicon than the other samples. Most of the coal detected in that sample contained low silicon concentrations, but this high silicon spectrum was plotted out to show that a little variation did exist in the coal dust. The SEM photomicrographs show individual oil soot particles, coal dust chips and a coal ash particle. A EDX spectrum was plotted of the Blank showing a typical background with no elemental markers present.

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The results of the TSP sample Q7621632 show that coal dust is the main component to the dust volume in this sample. Coal ash and oil soot was detected in lower concentrations. The remainder of this sample consists of typical outdoor dust particles (mineral matter, biologicals, ambiguous soots and vehicle soot). Sample Q7621644 contains only a low concentration of coal dust and a few large coal ash particles that account for 49% of the weight of the sample but only 3% of the number of particles counted. One of these lacy, pitted coal ash particles is shown in photo B on the TSP report for sample Q7621644. Mineral matter and biologicals account for the majority of this sample.

DISCUSSION:

A very high concentration of coal dust was detected in samples 082999-1, 082999-2, 083199-2, 090699-1 and Q7621632. Oil soot and or coal ash appears to be having an impact on the site were samples 082999-1, 082999-2, 083199-2, 090699-1 and Q7621644 were collected. The coal dust detected in these samples appears to be coming from the same source (a low iron containing coal). If a standard of any coal sources suspected at this area was submitted it could be compared to the coal dust detected in these samples. The oil soot detected appears to be coming from a single industrial source.

Should you have further questions, or need additional information, please do not hesitate to contact me or client services at any time.

Sincerely,

John H. Knowles
SEM Supervisor

SEVERN TRENT LABS, INC.
Total Suspended Particulate Analysis by Polarized ight Mi roscopy
Version 4.3 (c) Copyright 1989 by EAL, 1998 by STI

IENT NH Dept of Environmental Services

AM Q7621632 ıg/cubic mete = 0

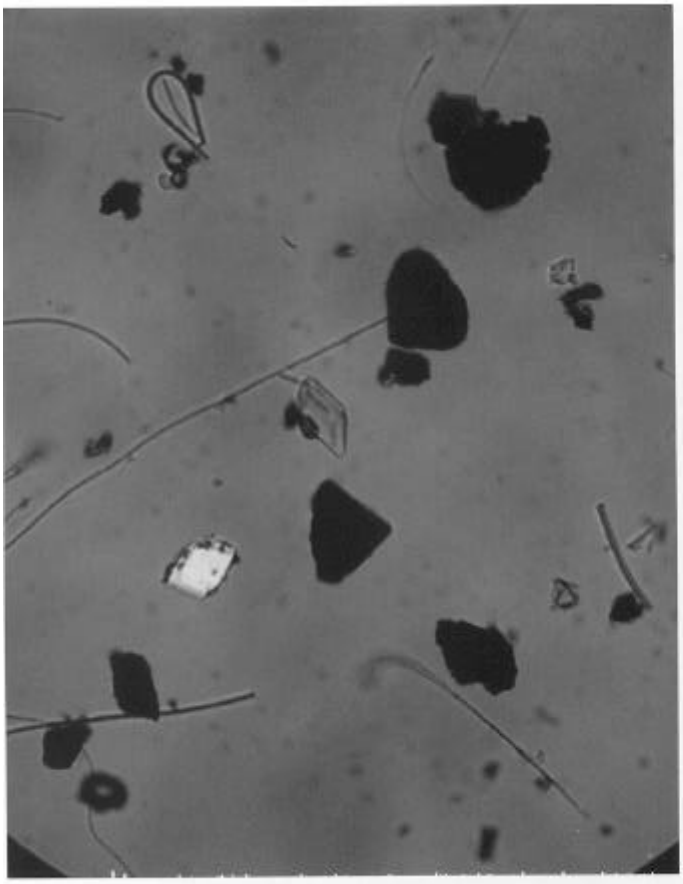
ANALYZED B' John Knowles 19· 999 STL JOB NO.: 2815

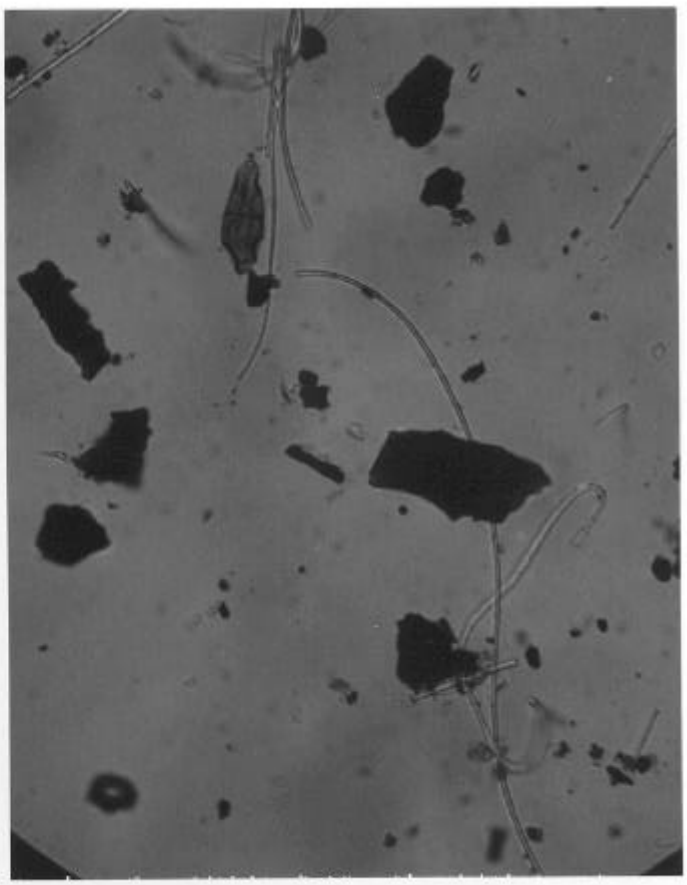
TYPE	WEIGHT %	NUMBER %	MEAN DIAM.(uM)	DENSITY
MINERALS	4(	19	8	G= 2.7
AMB. SOOTS	4		9	G= 1.1
OIL SOOT		2	11	G= 1.1
VEH. SOOT		1	10	G=
COAL DUST	44	56	10	G= 1.4
COAL ASH		6	7	G= 2.7
BIOLOGICAL		9	11	G=

AL OL 00

PHOTO A 500X, PARTLY CROSSED POLARS, TYPICAL
PHOTO B 500X, PARTLY CROSSED POLARS, TYPICAL

-A- **-B-**





SEVERN TRENT LABS, INC.
Total Suspended Particulate Analysis by Polarized Light Microscopy
Version 4.3 (c) Copyright 1989 by EAL, 1998 by STL

CLIENT: NH Dept. of Environmental Services

SAMPLE: Q7621644 SP (ug/cubic meter) = 0

ANALYZED BY: ohn Knowles 11-19-1999 STL JOB NO.: 28155

TYPE	WEIGHT %	NUMBER %	MEAN DIAM.(uM)	DENSITY
MINERALS	35	48	9	G= 2.7
AMB. SOOTS	1	16	6	G= 1.1
OIL SOOT	<1	1	10	G= 1.1
VEH. SOOT	<1	2	8	G= 1.1
COAL DUST	<1	4	4	G= 1.4
COAL ASH	49	3	33	G= 2.7
BIOLOGICALS	15	26	8	G= 1.5

TOTAL COUNT 100

PHOTO A 500X, PARTLY CROSSED POLARS, TYPICAL
PHOTO B 500X, PARTLY CROSSED POLARS, TYPICAL

-A- **-B-**

APPENDIX C

Photograph

This photograph was taken by a resident of Eliot on May 23, 1999 and forwarded to DES. The picture was taken from the Dixon Avenue area. Careful evaluation of the photograph, in particular the relative locations of smoke stacks at Schiller and Newington Stations, revealed that the high opacity black smoke shown rising on the left side of the picture was emanating from a source to the east of, and at a lower elevation than, the power plant stacks (which can be seen in the center and on the far right side of the picture). The source of the smoke is believed to be a vessel, the Kestrel, a 690 foot Liberian tanker offloading oil at the PSNH fuel pier, in the Piscataqua River on the date of the photo. Records obtained from the New Hampshire Port Authority indicate that during the study period, August 22 – September 19, 17 ships ranging in length between 160 and 730 feet passed this point in the river going to and then again coming from facilities along the river (34 passages).

APPENDIX D

Estimated Costs

DES Study Of Airborne Particulate Matter Concentrations and Deposition In Eliot, Maine

ESTIMATED COSTS

DES Study Of
Airborne Particulate Matter Concentrations and Deposition
In Eliot, Maine

LABORATORY FEES	RATE (PER SAMPLE)	SAMPLES	TOTAL
DES Laboratory	$50.00	15	$750.00
Severn-Trent Laboratories (Lump Sum)			$795.00
		SUBTOTAL =	$1,545.00

HUMAN RESOURCES	ESTIMATED HOURLY RATE	ESTIMATED TOTAL HOURS	ESTIMATED TOTAL COST
Technical Staff	$55.00	252	$13,860.00
Clerical Staff	$25.00	20	$500.00
Management	$75.00	222	$16,650.00
		SUBTOTAL =	$31,010.00

MISCELLANEOUS	ESTIMATED TOTAL
Power	$250.00
Incidentals (materials, etc.)	$450.00
Tool rental	$50.00
Printing	$1,000.00
SUBTOTAL =	$1,750.00

TOTAL ESTIMATED COST = $34,305.00